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DEMAND FOR COFFEE IN NORTH AMERICA

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Demand for Coffee in North America" submitted by Theodora S. Hyuha in partial fulfilment of the requirements for the degree of Master of Science.

DEDICATION

DEDICATED TO THE MEMORIES OF MY FATHER, THE LATE DONOZIUS K. SHUWU, MY MOTHER, MRS. M.F. NAMBOZO SHUWU,

AND

MY DAUGHTER, MUGOYA H.F. HYUHA WITHOUT WHOM MY ACADEMIC AND OTHER STRUGGLES WOULD HAVE BEEN DOOMED TO FAILURE.

FATHER, MAY YOUR SOUL REST IN PEACE.

ABSTRACT

This study is about the demand for coffee in the United States and Canada during the period from 1955 to 1977. In the course of the study, an examination of world trade in coffee and the terms of various international coffee agreements was undertaken. The demand for coffee in North America was analysed using econometric techniques. Single equation models of the demand for coffee were formulated. The models were based on the traditional consumer theory of demand. Both linear and double-logarithmic models were employed in the analyses. The models were then estimated by means of multiple regression analysis. Further, own-price, income, and cross-price elasticities of the demand for coffee were computed using the estimated coefficients of the models. In the case of the United States, both the wholesale level and retail level prices of coffee, tea, cocoa, and sugar were used in the econometric analyses. Lack of data led to only wholesale level prices being used in the Canadian case.

The results found indicated that the demand for coffee in both the United States and Canada is inelastic with respect to coffee prices. The calculated own-price elasticity of demand for coffee varied between -0.01 and -0.28 in the United States and between -0.03 and -0.22 in Canada. The calculated income elasticity of demand for coffee ranged from -0.68 to 0.91 in the United States and from -0.78 to -0.07 in Canada. In addition, all the cross-price elasticities (with respect to cocoa, tea, and sugar) were also found to

be less than unity in absolute values. All of these commodities were found to be complements to coffee in North America, although cocoa and tea were expected to be substitutes to it.

In light of these results, it is recommended that a comprehensive agreement between coffee producers and consumers is still desirable. The activities of the International Coffee Agreement should, therefore, be continued. Further, where feasible, producers should intensify their efforts towards diversifying away from coffee into alternative crops. More research is needed insofar as expanding alterative uses or markets for coffee is concerned.

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TABLE OF CONTENTS

* * * * *

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This study is about coffee,[1] a tree crop whose fruits are used as a non-alcoholic beverage. The tree begins to bear fruits at the age of three years and the yield continues until the tree is about fifty years old. The coffee tree grows mainly in the tropical and semi-tropical developing countries, at both low and high altitudes. Consequently, there are very few developing countries that do not grow coffee.

Singh et al, distinguish four distinctive types of coffee namely, arabicas, robustas, liberica, and excelsa.[2] Arabica and robusta are the most important in international trade. Liberica and excelsa are mainly grown in Western Africa and account for less than a half of one per cent of world production and exports. Robustas are mainly grown in hot and humid climates while arabicas require relatively lower temperatures, and are, therefore, grown either at higher altitudes or further from the equator in contrast to robustas.

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1 The word coffee, as used in this study, refers to green coffee beans in their unroasted form. No attempt is made here to distinguish among varieties of coffee. Thus, coffee is treated as a homogeneous product in this study.

2 See Shamsher Singh et al., Coffee, Tea, and Cocoa: Market Prospects and Development Lending, World Bank Staff Papers Number Twenty-two (Baltimore: The John Hopkins University Press for the World Bank, 1977), pp. 24-25.

Abaelu and Manderscheid subdivide the first two types of coffee (arabica and robusta) into different varieties.[1] The major varieties so distinguished are milds, brazils, and robustas. Milds are usually considered as premium coffee, and, therefore, command a premium price over the robustas. The robustas are less favoured because of their bitter nature.

Coffee is an important source of foreign exchange for many developing countries. For example, during the period from 1970 to 1972, five developing countries derived 55 per cent of their foreign exchange from coffee proceeds. Specifically, the contributions of coffee exports to total foreign exchange earnings were as follows: Portuguese Timor, 90.5 per cent; Burundi, 73.0 per cent; Uganda, 58.8 per cent; Columbia, 58.8 per cent; and Rwanda, 57.3 per cent.[2] Foreign exchange is a vital factor in economic development. It is one of the major ways by which capital and other goods necessary for development can be imported into a country. Therefore, it is important that coffee producing and exporting countries have accurate and up-to-date information concerning coffee markets in order for them to be able to make rational decisions in regard to the production and marketing of the crop.

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1 See Nduka J. Abaelu and V. Lester Manderscheid, "United States Import Demand for Green Coffee by Variety", American Journal of Economics. 50 (1968): p. 232.

2 Singh et al., Coffee, Tea, and Cocoa, p. 34.

The Problem

In general, studies of demand in agriculture are useful to both consumers and producers. The producers require such knowledge in order to make rational decisions regarding production and supply so as to maximize their revenues. Information on demand may be useful to exporting nations as a guide to whether or not it would be beneficial if their governments entered into trade agreements with importers.

Coffee prices have traditionally been subject to fluctuations. Two periods of marked price increases were in the early 1950's and after the 1975 frost in Brazil. The high coffee prices in the early 1950's encouraged new coffee plantints. These plantings reached maturity in the late 1950's and early 1960's. Consequently, between 1957 and 1962, there was a marked increase in production of coffee. This increased output accompanied to declines in world coffee prices during that period (Figure 1). Stabilization activities were begun in 1963 under the International Coffee Agreement. These activities not only prevented coffee prices from declining further but increased and stabilized them appreciably.[1] Through out the 1960's less severe flucutations in coffee prices occurred as these stabilized around the 1963 levels. Howeven, in the 1970's, and especially from 1975, there have been sharp increases in world prices for coffee.

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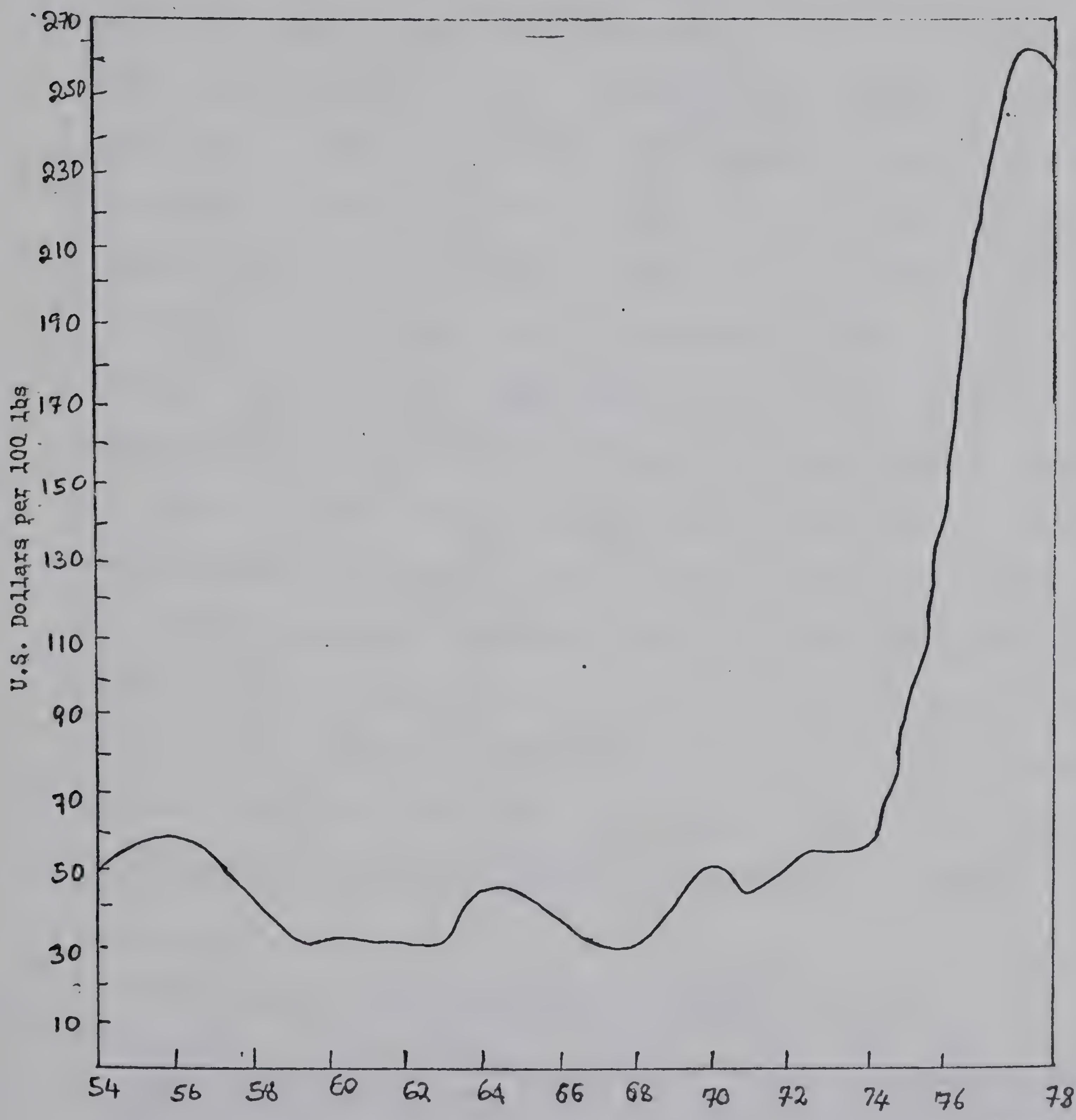
1 The International Coffee Agreement was founded in 1962. This agreement is discussed in more detail in Chapter II.

FIGURE 1

AVERAGE ANNUAL WHOLESALE PRICES OF COFFEE AT

NEW YORK, 1954-1977



SOURCE: International Monetary Fund, International Financial Statistics (Washington, D.C.: I.M.F., Annual Issues).

As pointed out earlier, coffee export earnings account for a large proportion of total foreign exchange earnings in a number of developing countries. Because of the unpredictable fluctuations in market prices (as well as in the quantities produced and exported), these earnings are also variable. There is, therefore, a need to shed more light on the factors which influence the demand for coffee (let alone those which affect its supply). North America in general, and the United States in particular, is the largest importer of coffee. However, over time coffee imports into that region have shown a downward trend. For instance, between 1967 and 1977 there was a 10 per cent decline in coffee imports into North America. The per capita consumption of coffee in the region has declined since 1962.[1] Most of this decline, as Timms[2] notes, is due to the increased use of instant (soluble) coffee as well as the increased consumption of lower strength of coffee. Since the United States is still the leading coffee importer, estimates of demand elasticities for coffee in this market should be of considerable interest to such coffee producing countries as Uganda.

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1 Singh _et al_., _Coffee, Tea, and Cocoa_, p. 35.

2 Daniel E. Timms, _World Demand Prospects for Coffee in 1980 with Emphasis on Trade by less Developed Countries_, Report No. 86 for the U.S. Department of Agriculture Economic Research Service, Washington, D.C., March, 1973.

Objectives of the Study

The principal objectives of this study are:

(1) to provide a brief overview of world production and consumption of coffee;

(2) to estimate the effect of changes in price, income, and population levels on the consumption of coffee in North America using econometric methods;

(3) to use these estimated parameters to calculate the price and income elasticities of demand for coffee in North America; and,

(4) to explore the implications of these results for both importing and exporting countries.

Hypotheses

It is hypothesized that for both Canada and the United States:

(1) the consumption of coffee is directly related to consumer incomes;

(2) the consumption of coffee varies inversely with the prices of coffee;

(3) changes in population levels explain a high percentage of the variation in the consumption of coffee;

(4) tea and cocoa prices are directly related to the consumption of coffee (i.e., that tea and cocoa are substitute goods for coffee); and

(5) the consumption of coffee varies inversely with the retail prices of sugar (i.e., that sugar is a complementary good to coffee).

Scope and Nature of the Study

The focus of this study is on analysing the demand for coffee in North America over the period from 1955 to 1977. Because of data limitations the study treats coffee as a homogeneous product although a more detailed study would involve analysis of the demand for different coffee varieties rather than for coffee at large. Average annual data for all the variables used in this study were obtained from published sources. The analysis of these time series data is done using single-equation multiple regression models. Based on the models, elasticities - price, income, and cross-price - are then calculated. Finally, the major implications of the results are discussed.

Format of the Thesis

In Chapter I, the problem, the objectives of the study, and the hypotheses raised by the problem are outlined. Chapter II provides an outline of the world coffee economy. This chapter includes a discussion of trends in the production and consumption of coffee by the major producing and consuming countries as well as a brief description of the International Coffee Agreement.

Chapter III reviews the literature and some of the available evidence on the demand for coffee in North America. A discussion of the models employed in the subsequent econometric analysis is then undertaken. Chapter IV presents the results of the statistical analysis together with a discussion of these results and of the limitations encountered in their derivation. Finally Chapter V notes some major policy implications of the results.

CHAPTER II

THE WORLD COFFEE ECONOMY

In this chapter, an overview of the world coffee economy is given in terms of the world supply of and the demand for coffee as well as the distribution of the commodity. The analysis begins with an outline of production and exports.

World Coffee Production and Exports

Tables 2-1 through 2-4 show the volume, share, exports, and value of coffee by major producing and exporting countries for the period from 1961 to 1976. As can be seen from these tables, Brazil clearly dominates in both production and exportation of coffee. Before World War II, Brazil alone produced up to 90 per cent of world coffee supplies. However, since that time, Brazil's share in world production and exports has been declining. For example, as Table 2-1 shows, that nation's production declined from 1,283.5 thousand metric tons[1] in 1969 to 389.1 tons in 1976. In terms of its share in world coffee production, Brazilian production in 1976 was about 11.0 per cent as compared to a share of 29.9 per cent in 1969, as Table 2-2 shows.

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1 Through out the text, tons will be used to stand for thousand metric tons.

TABLE 2-1

COFFEE PRODUCTION BY MAJOR PRODUCING COUNTRIES,[1] 1961-1976

(in thousands of metric tons)

Country	Average Annual 1961-65	1968	1969	1970	1971	1972	1973	1974	1975	1976
Africa	995.9	1183.9	1256.0	1345.2	1170.8	1255.5	1362.1	1291.1	1188.1	1228.4
Angola	185.0	198.0	215.0	204.0	228.0	225.0	210.0	224.8	68.4	72.0
Ivory Coast	188.0	287.8	210.1	279.6	239.7	268.8	301.8	195.9	270.4	304.8
Ethiopia	141.9	165.0	170.0	175.5	100.5	112.5	155.5	157.9	173.7	170.0
South America	2520.8	1729.6	1965.6	1465.5	2226.8	2118.3	1610.5	2294.1	2026.4	1117.5
Brazil[2]	1181.1	1057.7	1283.5	754.8	1151.5	1495.7	872.9	1610.0	1263.0	389.1
Columbia	468.4	480.0	480.0	507.0	468.0	432.0	538.0	468.0	540.0	510.0
Central America	645.1	670.4	711.3	734.6	772.8	777.0	806.0	790.0	839.9	866.4
Asia and Oceania	256.8	313.7	361.3	364.9	405.4	365.0	364.9	383.8	411.5	419.2
World	4418.6	3897.6	4294.3	3909.3	4575.8	4515.7	4143.5	4759.1	4455.8	3631.4

1 "Coffee" refers to the coffee beans before grinding and roasting.

2 Official data reported in terms of dry cherry converted into clean coffee at 50 per cent.

SOURCE: United Nations, Statistical Yearbook, 1978.

TABLE 2-2

PERCENTAGE SHARE OF COFFEE PRODUCTION BY

MAJOR PRODUCING COUNTRIES, 1961-1976

Country	Average Annual 1961-65	1968	1969	1970	1971	1972	1973	1974	1975	1976
Africa	22.5	30.4	29.2	34.4	25.6	27.8	32.9	27.1	26.7	33.8
Angola	4.2	50.8	5.0	5.2	4.9	4.9	5.1	4.7	1.5	1.9
Ivory Coast	4.3	7.4	4.9	7.2	5.2	5.9	7.3	4.1	6.1	8.4
Ethiopia	3.2	4.4	3.9	4.5	2.2	2.5	3.8	3.3	3.9	4.7
South America	57.0	44.4	45.8	37.5	48.7	46.9	38.9	48.2	45.5	30.8
Brazil	42.6	27.1	29.9	19.3	25.2	33.12	21.1	33.8	28.3	10.7
Columbia	10.6	12.3	11.2	12.9	10.5	9.6	12.9	9.8	12.1	14.0
Central America	14.6	17.2	16.6	18.8	16.9	17.2	19.5	16.6	18.8	23.9
Asia and Oceania	5.8	8.0	8.4	9.3	8.8	8.0	8.8	8.0	9.2	11.5
World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

SOURCE: Calculated from Table 2-1.

The reasons frequently given for this decline include weather influences, the age of that country's coffee trees, the abandonment of acreages of coffee, and soil erosion. However, government intervention to control coffee production and thus affect export prices is generally accepted as being the most important factor.[1] Successful diversification of the economy may be an associated factor. For many years, the Brazilian Government has attempted to control the quantity of Brazilian coffee that reaches the world market and thus control and maintain world prices for it. These activities by the Brazilian Government appear to have effectively maintained a "price umbrella" which has encouraged African countries to increase production and thus gain a substantially larger share of the world market. Law notes:

> The earlier restrictions by Brazil and Columbia had influenced the price but had prompted expansion in Africa. From 1946 to 1956, total exports had risen by 30 per cent, while Brazil's had risen by only 8 per cent and Columbian exports had not shared any of the gain.[2]

Columbia is the next most important coffee producing country. Columbia's coffee production was 480.0 tons in 1969 and grew to 510.0 tons in 1976. This amounts to over 10 per

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1 V.D. Wickzer, Coffee, Tea, and Cocoa: An Economic and Political Analysis (Stanford: Stanford University Press, 1955), p. 134.

2 Alton D. Law, International Commodity Agreements: Setting, Performance, and Prospects (Lexington: D.C. Heath and Company, 1975), p. 43.

cent of world coffee production. There is then a long list of small producers, the largest of which are Angola, Ivory Coast, and Ethiopia, which account for 5 per cent, 4 per cent, and 2 per cent of total production, respectively.

The volumes of production and supplies to world markets from producing countries do not always coincide as some of the coffee is either consumed or stored within the producing country. Thus, a distinction is made between total production and exportable production which is defined as total production minus domestic consumption and storage. For example, during the period from 1967 to 1977, Brazil's share in exportable production averaged about 20 per cent while her share in total production was 30 per cent on the average during the period. Mexico, which is first among the Central American countries as a coffee producer, ranks third as a coffee exporter in the region.[1]

As can be seen from Table 2-1, world coffee production has fluctuated considerably over time. But world exports have tended to increase as Table 2-3 shows.

World exports increased from 271,521 tons in 1961 to 3,555,135 tons in 1976. This represents an increase of about 12.09 per cent over the period (1961 to 1976). Note that the increase was not uniform throughout this period.

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[1] Singh, _et al._, _Coffee, Tea, and Cocoa_, pp. 27-30.

While trending upwards, there was marked variation in exports from year to year. A marked increase was in 1973 when 3,741,253 tons of coffee were exported. This increase reflected an abandonment of the International Coffee Agreement which had initially applied from 1968 to 1972.

Table 2-3 shows that the major coffee exporters are developing countries. South America, the leading exporting region, exported an annual average of 1,551,147 tons during the period from 1967 to 1970. Exports from this region declined to 1,341,832 tons by 1976 - a decline of 13.5 per cent over the six-year period, from 1970 to 1976. This overall decline in exports of volume of coffee in the region may be explained by Brazil's pursuit of a restrictive production and export policy. Together these two forces led to a marked decline in exports especially during the period from 1974 to 1976. During this period Brazil exported an annual average of 667,247 tons of coffee as compared to an annual average of 1,008,291 ton during the period from 1961 to 1973, a 34 per cent decline. While Brazil's exports declined, particularly during the period from 1974 to 1976, exports from Columbia (the next most important exporting country in the region) increased from 412,373 tons in 1974 to 488,270 tons in 1975 though there was a decline in the exports of coffee from this country of about 24.0 per cent in 1976.

The next most important coffee exporting region is Africa. Africa as a whole exported 896,421 tons on average

TABLE 2-3

COFFEE EXPORTS BY MAJOR EXPORTING COUNTRIES 1961 TO 1976

(in metric tons)[1]

EXPORTER	1961	1962	1963	1964	1965	1966	1967	1968
Africa	658850	729640	789460	848820	843430	940490	902930	987340
Angola	118210	156890	137930	138810	159170	156410	196510	188580
Ivory Coast	154710	144660	182070	204270	185650	181520	149130	214490
South America	1442020	1472970	1639630	1374320	1253960	1449390	1495700	1620450
Brazil	1018230	982570	1170780	896770	808930	1009910	1004250	1107470
Columbia	339050	393690	367940	384720	338060	333870	365620	395270
Central America	421030	489250	461370	489110	469790	492710	474760	527810
World	2715210	2842790	3087870	2856150	2755420	3086280	3161640	3353790

TABLE 2-3 (continued)

EXPORTER	1969	1970	1971	1972	1973	1974	1975	1976
Africa	98209	1011163	988862	1081045	1190678	1107073	1108083	1160419
Angola	182943	180581	181550	176855	212866	263621	163000	83700
Ivory Coast	178325	195342	184979	184979	188731	218655	254991	322825
South America	161995	1473448	1540773	1582014	1635717	1206215	1397714	1341832
Brazil	1121375	962629	1034266	105156	1071377	683784	805567	512391
Columbia	388619	390377	393354	390813	405065	412373	488270	37122
Central America	510443	502390	514619	611776	662871	681560	705456	767929
World	3433159	3278758	3301216	3510924	3651229	3391274	3569164	3671076

SOURCE: Food and Agriculture Organization of the U.N., Trade Year Book, various issues.

during the period from 1967 to 1970 and an annual average of 957,693 tons during the period from 1971 to 1976. This represented a 6.8 per cent increase over these two periods. This apparent increase in volume of coffee exported was largely at the expense of Brazil, as already explained.

Table 2-4 presents information on the value of exports from the major exporting countries. The value of exports from South America averaged 1.3 billion dollars (U.S.) annually over the period from 1967 to 1970. The value of these exports increased to 3.5 billion dollars (U.S.) in 1976. While South America's export earnings from coffee were declining, those of Africa were increasing. Over the same period from 1967 to 1970, Africa's annual average export earnings from coffee were $U.S. 0.69 billion. By 1973, this region's export earnings had reached $U.S. 1.19 billion and by 1976 export earnings had increased to $U.S. 2.2 billion. This represents an increase of 218 per cent over the period from 1970 to 1976. Although there has been a dramatic overall increase in export earnings from Africa, individual countries showed mixed performances. For instance, Angola, once a leading exporter of coffee in Africa, ranked last as far as value of export earnings were concerned in 1976. In 1975, when world coffee prices were high,[1] Angola experienced

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1 See Figure 1, Chapter 1.

TABLE 2-4

VALUE OF COFFEE EXPORTS BY MAJOR EXPORTING COUNTRIES

(thousands of U.S. dollars)

EXPORTER	1961	1962	1963	1964	1965	1966	1967	1968
Africa	342620	380160	435250	616030	542870	650080	608820	681690
Angola	48670	64840	66230	99510	93470	106380	123370	122800
Ivory Coast	82310	78080	99140	128510	104880	122520	103080	145320
South America	1079980	1042810	1123030	1231170	1140510	1173840	1116350	1205710
Brazil	642670	748280	748280	759700	706590	763980	704730	774480
Columba	307830	332020	303010	394230	343900	328260	322320	349210
Central America	329600	368650	339080	432060	430130	435800	373970	410500
World	1821170	1854470	1983900	2370560	2231670	2368100	2238000	2427630

TABLE 2-4 (continued)

EXPORTER	1969	1970	1971	1972	1973	1974	1975	1976
Africa	650626	816470	791515	901699	1199232	1330900	1305587	22326260
Angola	112589	134978	142598	140743	210440	247360	200000	149000
Ivory Coast	116922	155454	151947	144261	196949	265368	286860	356372
South America	1232020	1518451	1260343	1538441	1918078	1623316	1673225	3512967
Brazil	812955	939266	772479	989219	1244272	864313	854513	2172687
Columbia	343937	466742	366923	429578	596894	624301	671077	967762
Central America	408733	524719	479944	561856	802344	951837	1744439	2936068
World	208702	3036632	2707217	3181288	4722115	4294389	4302065	8341025

SOURCE: Food and Agriculture Organization of the U.N., Trade Year Book, various issues.

a 19 per cent decline in export earnings from those of the previous year (1974). The trend continued into 1976, when the export earnings from coffee declined by 25 per cent. Over a two year period from 1974 to 1976, there was an overall decline in export earnings from coffee of 39 per cent. However, in the same period, Ivory Coast's export earnings from coffee increased by 8 per cent from 1974 to 1975 and 24 per cent from 1975 to 1976; that is, by 34 per cent over the whole period from 1974 to 1976.

World Coffee Consumption and Imports

Table 2-5 shows the major coffee importing countries. As can be seen from the table, the major coffee importing countries are all developed countries. In 1977 Western Europe together with North America accounted for over 80 per cent by volume of world coffee imports. Western Europe imported an annual average of 1,525,134 tons over the period from 1967 to 1970. By 1977, this region's imports had risen to an annual average of 1,699,396 tons. There was an increase of 11.4 per cent over the ten-year period, that is, from 1967 to 1977. Individually, the Federal Republic of Germany is the leading importer accounting for 22.5 per cent of the total Western imports in 1977. The Federal Republic of Germany is followed by France which had a 15.8 per cent share of the volume of coffee imported into that region in 1977. The third more important importer of coffee within the region is the Netherlands with a 7.4 per cent share.

TABLE 2-5

GREEN COFFEE IMPORTS BY MAJOR IMPORTING

COUNTRIES, 1967-1977

(in thousands of metric tons)

IMPORTER	Annual Average 1967-1970	Annual Average 1971-1974	1975	1976	1977
W. Europe	1,525,134	1,741,256	1,891,057	1,964,752	1,699,396
Federal Rep. of Germany	298,925	334,594	373,433	391,707	382,026
France	236,616	266,526	294,815	292,547	267,813
Netherlands	107,466	133,616	161,572	172,547	125,270
North America	1,389,484	1,350,862	1,327,849	1,312,981	1,008,502
United States	1,303,639	1,264,536	1,233,843	1,206,246	912,706
Canada	82,628	83,167	89,923	84,923	73,166
Asia	141,253	220,809	184,682	244,862	210,539
Japan	56,700	96,145	109,651	147,641	133,919
Africa	82,483	71,028	89,811	88,566	69,536
Australia	18,697	23,931	27,824	25,814	28,742
World	3,244,618	3,465,850	3,636,815	3,729,186	3,093,199

SOURCE: Food and Agriculture Organization of the U.N., Trade Yearbook, various issues.

Western Europe is followed by North America insofar as the importation of coffee by region is concerned. Although Western Europe, as a whole, is the leading area in coffee importation, an examination of individual countries shows that the United States is still by far the largest importer of coffee although this country's imports of the commodity are declining. Over the period from 1967 to 1970, the United States imported an annual average of 1,303,639 tons of coffee. This represented 42.8 per cent of the world volume of coffee imports during the period from 1967 to 1970. By 1977, the United States share in the volume of world imports had declined to 29.5 per cent when the United States imported an annual average of 912,706 tons of coffee. Canada imported an annual average of 82,628 tons during the period from 1967 to 1970. This represented a 2.5 per cent share of the volume of world imports during the period from 1967 to 1970.

The continent of Asia as a whole is a minor importer of coffee, accounting for only 6.8 per cent of the volume of world imports in 1977. This is not surprising for most of the Asian countries are traditionally tea drinkers. Nevertheless, a note has to be made about Japan's coffee imports during the period from 1967 to 1970 was 56,700 tons. By 1977, the imports into this country had more than doubled; they had reached 133,919 tons by 1977.

Table 2-6 shows the value of world coffee imports by the major importing countries. Starting from the year 1975, there was a dramatic increase in value of the volume of the world of coffee exported. For instance, between the year 1975 and 1976, there was an increase of 73 per cent. This increase was due to price increases which were largely due to production falls in Brazil. Frost damage to the Brazilian coffee crops of 1975 were associated with a remarkable increase in world coffee prices. The New York Coffee Exchange recorded an annual average price of 83.1 U.S. cents per pound for Columbian varieties in 1975, an increase of 6.5 per cent over the previous year. This increasing price trend continued through 1976 and 1977 when annual average coffee prices of 157.4 and 242.5 U.S. cents per pound were recorded at the New York Coffee Exchange for the Columbian coffee varieties. However, in 1978 this upward trend was reversed. The New York Coffee Exchange recorded annual average prices of Columbian varieties of 187.6 and 193.8 U.S. cents per pound in 1978 and 1979, respectively.

Problems for Exporting Countries

The fluctuations in prices which are evident for

TABLE 2-6

VALUE OF COFFEE IMPORTS BY MAJOR IMPORTING

COUNTRIES, 1967-1977

(thousand U.S. dollars)

IMPORTER	Annual Average 1967-1970	Annual Average 1971-1974	1975	1976	1977
W. Europe	1,358,013	2,094,514	2,666,174	4,692,227	4,805,538
Federal Rep. of Germany	295,873	441,514	538,325	1,004,413	1,871,485
France	196,857	294,164	382,630	648,825	1,254,446
Netherlands	97,114	168,208	239,196	444,947	612,729
North America	1,118,470	1,474,688	1,727,650	2,922,679	4,369,602
United States	1,042,448	1,370,441	1,587,503	2,680,721	3,972,699
Canada	72,609	99,725	133,742	217,608	354,292
Asia	83,520	61,106	242,462	509,585	937,438
Japan	36,417	88,366	152,354	339,762	661,815
Africa	49,959	54,183	89,811	88,566	69,536
Australia	13,546	22,994	32,290	37,815	93,849
World	3,692,642	3,916,278	4,928,962	8,549,231	14,039,768

SOURCE: Food and Agriculture Organization of the U.N., Trade Yearbook, various issues.

coffee is a major problem for exporting countries.[1] Both short-run and long-run cyclic fluctuations in prices are event. Major causes of these are: variations in supply, inelastic supply, and inelastic demand. Variations in supply are normally due to such natural forces such as weather, frost, and pests, though political disruptions in producing countries have at times been a major contributor. Seasonal price changes for coffee are marked especially in African countries. In these countries, the lack of storage facilities and the need for cash by farmers lead to the crop being marketed at the time of harvest. Besides, the coffee year normally begins at approximately the same time among all African countries thus aggravating the seasonality problem.

Price changes take time to induce compensating changes in supply because of the unusual nature of coffee trees: they have a gestation period from two to four years. Thus price changes have a lagged effect on supply. In addition, on the demand side, speculative activities from time to time appears to enhance price fluctuations. For instance, expected from damage in any major supplying country

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1 The significance of this effect is explicitly discussed in the Food and Agriculture Organization of the United Nations (F.A.O.), The World Coffee Economy, Commodity Bullentin Series (C.B.S.) No. 33, p. 194. Also quoted is Paul Streeten and Dave Elson, Diversification and Development: The Case for Coffee, (New York Praeger Publication, 1971, p. 15.

such as Brazil may influence marketing activities to the point that there are marked movements in prices, Law notes a case in point, stating that a rise to 75 U.S. cents per pound in 1974 from 65 U.S. cents per pound in 1976 was partially explained by the non-realization of the anticipated major frost damage to coffee in Brazil.

Previous studies suggest that the demand for coffee as for many other food crops is highly price inelastic. Hence a shift in the supply of coffee leads to more extreme price fluctuations than if demand was relatively more price-elastic. Price fluctuations, are believed to translate into fluctuations in the levels of income of major coffee exporters, and thus into their employment and general price levels. The study by Gerard Adams et al., established that fluctuations in the coffee market have magnified impacts on the variables of the Brazilian economy.[1] However, MacBean and Bakisubramaryam argue otherwise. They believe that export instability may not be as harmful as has often been stated.[2] Nevertheless, the fluctuations in export earnings

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1 Gerard F. Adams, Jene R. Belirman, and Ricmualdo A. Rothdan, "Measuring the Impact of Primary Commodity Fluctuations on Economic Development: Coffee and Brazil", American Economic Review, 69 (May, 1979, p. 166.

2 For this argument see Alasdair I. MacBean and V.N. Bakisubramaryam, Meeting the Third World Challenge, (London: The Macmillan Press for the Trade Policy Research Centre, 1978), pp. 166-67.

in Uganda, usually leads to serious fluctuations in GNP.[1]

In general, it is recognized that coffee exporters do face an uncertain market. This uncertainity results from price fluctuations which may in turn disrupt economic development. As early as the beginning of this century, Brazil instituted controls aimed at stabilizing the coffee market. These market stabilization policies initially met with little success.[2] By the beginning of World War II, it became apparent that if the "coffee problem" was to be solved on a global basis, a wider effort by the producing and consuming countries was needed. This search for a solution materialized in 1962 when the International Coffee Agreement (I.C.A.) was signed.

The International Coffee Agreement[3]

Early efforts to control the world coffee economy were applied at both national and regional levels. Brazil

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1 Alasdair I. MacBean writing in 1966, concludes that domestic incomes of Uganda fluctuated in sympathy with export earnings. However, he could not draw the same conclusion about the link between employment, prices, and export earnings due to lack of data. Alasdair I. MacBean, Export Instability and Economic Development, (Cambridge Mass.,: Harvard University Press, 1966), p. 148.

2 For a discussion on this point see the following two books: William E. Haviland, International Commodity Agreements, p. 12; and Alton D. Law, International Commodity Agreements, p. 40.

3 This section draws heavily on material presented by Bart S. Fisher, The International Coffee Agreement: A Study in Coffee Diplomacy, (New York: Praeger Publisher, 1972) pp. 13-14.

was the first to attempt to buy up a portion of domestic coffee under a regional "Volorization Scheme". The aim of this scheme was to increase coffee prices.

As Fisher notes, these schemes met with limited success. Though world prices increased, this was temporary since, as Fisher points out, new plantings in states other than Sao Paulo and in other countries elsewhere were encouraged. Brazil next attempted a "permanent defence of coffee" which also met with difficulties.[1] Under this scheme, according to Haviland, Brazil burnt over ten billion pounds of green beans equivalent.[2] This scheme was abandoned in 1937.[3]

Renewed efforts to control the market for and price of coffee came during World War II when shortages of crops including coffee appeared. An Inter American Coffee Agreement was signed between Latin American coffee producing countries and the United States. This agreement was signed on November 28, 1940.[4] The agreement was renewed from year to year until 1948.[5]

After World War II, many other coffee producers initiated measures aimed at stabilizing the local coffee

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1 William E. Haviland, International Commodity Agreements, p. 14.

2 Ibid., p. 14

3 Ibid., p. 14

4 Bart Fisher, The International Coffee Agreement, p. 15.

5 William E. Haviland, International Commodity Agreement, p. 15.

economy. For example, a scheme was started in Uganda whereby a fund was established termed the "Coffee Price Assistance Fund". This scheme was intended to stabilize domestic coffee prices. Under the scheme the domestic price was kept fairly constant and was lower than the world price. The main objective was that the funds in the Coffee Price Assistance Fund would grow during boom years and decrease during slump years and thus by stabilizing prices, would also help stablize incomes accruing to farmers. In practice funds such as this also served as taxing mechanism to tax earnings in this sector of the Uganda economy.[1] Similar schemes were instituted in West Africa with the similar objective of withholding part of the farmers' incomes in periods of high prices, to supplement these in period of low prices. These schemes, explained Bauer and Paish, virtually covered all agriculture exports, notably cocoa, oil palm produce, groundnuts, and cotton.[2]

The Latin American Coffee Agreement[3]

As explained earlier, Brazilian efforts to control

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1 For details on the Coffee Price Assistance Fund, refer to Ian Livingstone and Henry W. Ord, Introduction to Economics for East Africa (London: Heinemann Educational Books, 1968) pp. 155-169.

2 For a discussion and evaluation of the performance of these schemes see Bauer, P.T. and Paish, F.W., "The Reduction of Fluctuations in the Incomes of Primary Producers", Economic Journal, Vol. LXIV, (Dec. 1954), pp. 757-764.

3 Bart Fisher, The International Coffee Agreement, p. 23.

the coffee economy did not materialize. As a result as Haviland notes:

> It became clear that unilateral action by a country controlling over half of the world's supplies could moderate the short-run market variations but could not cope with the long-run surpluses. Hence just before World War II, Brazil gave up trying single handedly to support world prices at the expense of her share of the market, and then the European market was shut off by hostiles.[1]

Following the abandonment of control by Brazil, on the initiative of the United States, a coffee study group was formed. The main aim of this group was to provide "technical" assistance about international agreements.

Negotiations followed between African coffee producing countries and coffee producing Latin American countries. According to Fisher, these negotiations failed to reach an agreement. The Latin American agreement was then signed instead.[2] The main objective of this agreement was to support the price of coffee. This was to be achieved through the withholding of a portion of the 1958/59 exportable production. (For instance, Brazil would withhold 40 per cent, Columbia 15 per cent, and other countries 19 per cent.)[3] In addition, Brazil was also to maintain the "coffee defence" plan, while other countries were to limit their exports to

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1 William E. Haviland, International Commodity Agreements, p.14.

2 Bart Fisher, The International Coffee Agreement, p. 23.

3 Ibid., p. 23

traditional markets. Inspite of this agreement, Fisher notes, "all arabica prices continued to decline. Robustas also fell, prompting the Africans to take a second look at International Agreements".[1] Hence the signing of the agreement in September, 1959 which included Portuguese colonies in Africa such as Angola, Cameroun, and Togo. Moreover the British and Belgians expressed moral support for the agreement.

The 1959 agreement covered a wide spectrum of features: export quotas, marketing, promotion, new markets, and administration.[2] Commentators, including Bart Fisher, note, in retrospect, two major problems with the agreement. First the annual coffee quotas under the agreement were too large, and second, export controls imposed under the agreement did no work effectively. Nevertheless, the agreement was reviewed in 1960. The 1960 agreement also included the United Kingdom (on behalf of Kenya, Tanganyika, and Uganda) among its members, in addition to Cameroun, Togo, and the Latin American countries.

International Coffee Agreement, 1962

The International Coffee Agreement was signed in 1962. This agreement included both producing and importing nations. It was prepared by the coffee study group and then adopted by the United Nations in the same year.

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1 *Ibid.*, p. 24.

2 *Ibid.*, p. 25.

The stated objectives of the 1962 International Coffee Agreement were:[1]

1) To achieve a reasonable balance between supply and demand on a basis which would ensure adequate supplies of coffee to consumers and markets for coffee to producers at equitable prices, and which would bring about long-term equilibrium between production and consumption;
2) To alleviate the serious hardships caused by burdensome surpluses and excessive fluctuations in the prices of coffee to the detriment of both consumers and producers;
3) To contribute to the development of productive resources and to the promotion and maintenance of employment and incomes in the member countries, thereby helping to bring about fair wages, higher living standards, and better working conditions;
4) To assist in increasing the purchasing power of the coffee exporting countries by keeping prices at equitable levels and by increasing consumption;
5) To encourage the consumption of coffee by every possible means; and,
6) In general, in recognition of the relationship of the trade in coffee to the economic stability of the markets for industrial products, to further international co-operation in connection with world coffee problems.

This agreement came into force in the same year. Prices rose sharply in 1963 and 1964. However, the exact causal relationship is in question as indicated by Law.[2] Law quotes Irving and Fisher among authors who thought that

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1 William E. Haviland, International Commodity Agreements, p. 15.

2 Alton D. Law, "Coffee: Structure, Control and Development: A Review Article", Inter American Economic Affairs, Vol. 27, No. 1 (Summer, 1973), p. 78.

the rise in prices was directly due to frost damage rather than to the International Coffee Agreement. Thomas Geer is among the authors who concludes otherwise. Law quotes Geer:

> "... The history of the 1964 price increase is a case in point. At that time Brazil did not fulfill its quota obligation inorder to raise the average indicator price."[1]

International Coffee Agreement, 1962: Appraisal

There are opposing views as regards the success of the 1962 International Coffee Agreement. Fisher and Geer suggest that with the agreement, the prices of coffee were maintained above the 1962 level with little instability. However, Law disputes this conclusion, and instead points out that price records show that price instability was at least 50 per cent greater with the International Coffee Agreement controls than without.[2] Nevertheless, Law agrees with MacAvoy's estimates that over $600 million a year was transferred to developing countries.[3]

The 1962 International Coffee Agreement was renewed for a further five year period in 1968. Prices rose sharply in 1970 and in 1972. These rises in prices, among other

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1 See Ibid., p. 78.

2 Ibid., p. 79.

3 Alton D. Law, International Commodity Agreements, p. 45.

things, led to discontent by importing countries with the workings of the agreement. Further some of the producing nations desired lighter restrictions under the agreement. Both of these features led to the collapse of the agreement in 1972.

The International Coffee Agreement, 1975

Following the collapse of the 1962 agreement in 1972, an interim agreement was entered into in 1973. This interim agreement did not, however, contain any economic provisions. A new agreement with such provisions did not materialize until 1975.[1] This agreement was to extend for a period of six years beginning in 1976.

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1 For more details concerning the 1975 I.C.A., see Shamsher Singh et al., Coffee, Tea, and Cocoa, p. 48.

CHAPTER III

THE DEMAND FOR COFFEE

A brief review of the major studies of the demand for coffee in the United States and Canada is given in the first part of this chapter. A discussion of the analysis of this study is then given. The variables chosen, the data sources, and the limitations of the data are outlined. The chapter concludes with a discussion of the estimating models and the method of analysis.

Review of Literature of the Demand for Coffee and Evidence

This section presents a discussion of some literature and evidence on the demand for coffee in both the United States and Canada. The first part of the review deals with the United States and second part with Canada.

Studies of the Demand for Coffee in the United States

Various studies of the demand for coffee in the United States were undertaken after the second World War. These include a study by Daly[1] and one by the United States Department of Commerce, Business and Defence Service

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1 Daly, F. Rex, "Coffee Consumption and Prices in the U.S.", Agricultural Economics Research 10 (July, 1958): pp. 61-71.

Administration.[1] These two studies, using time series data, indicated that the income elasticity of demand for coffee in the United States while positive was slightly lower than it had been during the earlier interwar period. They both suggested plausible reasons for that decline in the income elasticity of demand. One reason was the changed age of distribution of the population in the post-war period. The relative proportion of children had increased. Such a change in age distribution is important in that coffee drinking is negligible among children and small among teenagers. Second, there had been a remarkable increase in the consumption of instant coffee, which uses less green coffee beans than does regular coffee. Third, there was a steadily rising extraction rate of instant coffee from a given amount of green coffee beans.

A study by Lovasy[2] published in 1967 estimated a negative income elasticity of demand for coffee in the United States. Lovasy concluded that the negative income elasticity of demand was because a saturation level of consumption for the commodity had been reached.[3]

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1 U.S. Dept. of Commerce, Business, and Defence Service Administration, Coffee Consumption in the United States, 1920-65, Washington, D.C., 1961.

2 G. Lovasy, Development of U.S. Coffee Consumption: Analysis and Forecast, Economic Dept. Working Paper, No. 9, International Bank for Reconstruction and Development, November, 1967.

3 Ibid., p. 24.

Analysis by Timms[1] on data for the United States for the period from 1952 to 1965, also reached a conclusion that the negative income elasticity of demand for coffee in the United States was because the saturation level for the commodity had been reached. This study postulated that the per capita consumption of coffee was dependent on coffee prices, the retail prices of major substitutes (such as tea and cocoa) and time (as a proxy for "trend factors"). The estimates of income elasticity of demand from this study carried a negative sign. These estimates of income elasticity of demand ranged from -0.13 to -0.53, and the estimates of own-price elasticity of demand varied from -0.10 to -0.18.

When Timms used per capita consumption of liquid coffee instead of the green bean equivalent data as the dependent variable, this resulted in even lower estimates of both income and price elasticities of demand. Timms argued that this indication of reduced consumer sensitivity to coffee prices was due to the interaction of many forces. He noted that there had been an annual average decline in the per capita consumption of coffee of 0.4 per cent for the period from 1952 to 1965 while real per capita consumer expenditures on all items had increased by 2.2 per cent and real coffee prices per kilogram had declined by 4.4 per cent. At the same

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1 Daniel E. Timms, World Demand Prospects for Coffee in 1980 with Emphasis on Trade for less Developed Countries, Foreign Agricultural Economic Report No. 86, United States Government Printing Office, March, 1973.

time, there had been a shift in tastes towards a more watery brew and an increased use of solubles. Further more, he suggested, consumption of coffee might have reached physical saturation levels in both green bean equivalent and liquid terms. Timms drew a general conclusion that consumption of coffee in both green bean equivalent and liquid terms was not being replaced by other beverages.

Another study that investigated the demand for coffee in the United States was that by Parikh.[1] Parikh hypothesized that total annual coffee consumption is a stable function of income and that variations in imports of coffee are largely due to variations in inventory demand for this commodity. The estimated own-price elasticity of demand was -0.32.[2] Further investigation by Parikh, using the Houthakker and Taylor Model, yielded own-price elasticity of demand of -0.22 (from the unadjusted data series) and -0.42 for seasonally adjusted data.[3]

A similar study by Gray was published in 1971.[4] Gray concurred with earlier researchers that own-price and income variables had a limited influence in explaining the

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1 A. Parikh, "United States, European and World Demand Functions for Coffee", American Journal of Agricultural Economics, Vol. 55, No. 3, (August, 1973), pp. 490-494.

2 Ibid., p. 490.

3 Ibid., p. 491.

4 Frederick D. Gray, "The Down trend in U.S. Coffee Consumption", United States Department of Agriculture, National Food Situation, Economic Research Service of U.S.D.A., N.F.S. 138, November, 1971.

downward trend in coffee consumption. He attempted to investigate the influence of other factors such as the efficiency of extraction, the consumption of instant coffee, and the estimated use of robusta. The estimated model in its linear form was

$$Q = 26.8 - 0.185Y - 0.016P - 1.352I - 0.081C$$

where Q = annual per capita consumption of regular coffee, green basis, in pounds;

Y = share of the United States population under age 25;

P = retail price of roasted coffee, BLS, index (1967 = 100);

I = per capita consumption of instant coffee, green basis, pounds;

C = estimated robusta coffee use in regular coffee, per cent.

The estimated price elasticity of demand was -0.14 which was essentially consistent with the findings of other studies.[1] However, the other variables included in the model were not significantly different from zero. Gray, drew a tentative conclusion that increased use of robusta in regular coffee and the change in flavour did contribute to the decline in the consumption of coffee.

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[1] The income elasticity of demand was not reported in Gray's study.

A study by Abaelu and Manderscheid took a different approach from the studies so far reviewed.[1] The focus was on coffee varieties rather than coffee in general. The aim of this study was to investigate the relationships among the major coffee varieties traded internationally (robustas, arabicas, and brazils) and the factors influencing coffee prices by varieties. A nine equation model of the United States coffee market was constructed. This included import demand, export supply and stock demand functions describing the structural mechanism underlying the market for each of the three coffee varieties. A disaggregation of coffee was done because it was felt that there were significant economic differences among the varieties of coffee.

This study yielded income elasticity of demand estimates of 2.56, -1.12, and -0.55 for milds, brazils, and robustas respectively. The estimated own-price elasticities of demand were -5.55, -4.76, and -2.77 for the milds, brazils, and robustas in that order. On the basis of these results, the authors drew a tentative conclusion that premium coffee (milds) is a normal good in the United States, whereas the non-premium varieties such as robustas are inferior goods. Abaelu and Manderscheid stated "other relevant factors remaining constant, further growth in the U.S. per capita disposable income should boost the demand for milds in the United States".[2]

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1 John Nduka Abaelu and Lester V. Manderscheid, "U.S. Import Demand for Green Coffee by Variety", American Journal of Economics, Vol. 50, No. 1, (1968) pp. 232-242.

2 Ibid., p. 240.

This tentative conclusion was latter questioned by John Hughes. Hughes was not satisfied with the methodology used by Abaelu and Manderscheid.[1] His main objections were, first, that the categories used to represent varieties were not representative of the groups.[2] Second, he argued that the income coefficient estimates associated with the columbian milds were not highly statistically significant to warrant the conclusion drawn. Hughes stated "The cited evidence from the columbian milds equation is not persuasive, the income coefficient being positive but no larger than its standard error".[3]

Another study that investigated the demand for coffee among other commodities in the United States was by George and King.[4] George and King reported the income elasticity of demand for coffee as -0.047.[5] They projected that that expenditure on beverages (coffee and soup) would increase by 11.4 by 1980 over the period 1962-1966.[6]

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[1] John J. Hughes, "U.S. Import Demand for Green Coffee by Variety: Comment", American Journal of Economics, Vol. 51, (1969) pp. 926-928.

[2] Ibid., pp. 926-927, briefly discusses these categories.

[3] Ibid., p. 928.

[4] P.S. George and G.A. King, Consumer Demand for Food Commodities in the United States with Projections for 1980. California Giamnini Foundation, Monograph Number 26, March, 1971.

[5] Ibid., p. 70.

[6] Ibid., p. 106.

Studies of the Demand for Coffee in Canada

Two studies which present estimates of the elasticities of demand for coffee in Canada are reviewed here. The studies were those undertaken by Beckford[1] and by Timms.[2] Both authors concur on one point--that per capita consumption of coffee in Canada had been increasing rather than decreasing as was the case with the United States. As Timms noted; "Canadian per capita consumption has been increasing steadily during the post War II period and has more than doubled since the war".[3] This tendency has continued. Canadian per capita consumption of coffee increased by 35.5 per cent over the study period (1955-1977), and by 8.04 per cent since the report of Timms' study.[4]

Beckford examined the demand for various agricultural commodities in Canada during the period from 1926 to 1962. In regard to coffee, he estimated an income elasticity of demand of 0.227 and an own-price elasticity of -0.277. Both estimates were significant at the 1 per cent level. From these results Beckford concluded that coffee consumption in Canada increases as real disposable income increases. The estimated coefficients representing cross-price elasticities (coffee-tea) were not

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1 Mascell Leornard Beckford, "Demand Analysis for Selected Agricultural Commodities, Canada 1926-62", Ph.D. Thesis, Faculty of Graduate Studies and Research, The University of Manitoba, Winnipeg, 1964.

2 Daniel E. Timms, World Demand for Coffee, 1980, pp. 45-46.

3 Ibid, p. 42. See also Beckford "Demand Analysis" p. 117.

4 See Table D in the Appendix.

sufficiently statistically significant to clearly demonstrate that coffee and tea are substitutes.

Timms' study covered the period from 1952 to 1965. In reference to Canada, Timms' estimates of own-price elasticity of demand ranged from -0.15 to -0.40 and his estimates of income elasticity of demand ranged from 0.82 to 1.77. The own-price elasticity of demand estimates were thus generally consistent with those estimated by Beckford. Timms' estimates of income elasticity, though positive, are higher than those estimated by Beckford. Thus whereas the evidence from the previous studies on the United States data suggests that in that country coffee is inferior, in Canada, it seems to be a normal good.

In regard to the estimates of own-price elasticity for coffee in Canada, both the studies by Beckford and by Timms suggest that the magnitude of the price elasticity of demand is relatively small. This implies that future changes in the real price of coffee may not greatly influence coffee consumption in the country. On the basis of these estimated elasticities, Timms concluded that future demand for coffee in Canada will be affected more by growth in income than by changes in prices.

The Data: Canada

For the analysis of the demand for coffee in Canada, the data used in the study were obtained from published

sources. Data on national disposable income were obtained from Statistics Canada, National accounts, Income and Expenditure, cat. No. 13-201. The same source gives estimates on population levels in Canada. The wholesale prices of coffee, cocoa, and tea in Canada are obtained from International Financial Statistics, (Washington, D.C.: International Monetary Fund). Data on average annual per capita consumption of coffee in Canada are presented by Zuhair A. Hassan and Daniel Karamchandairi, Handbook of Food Expenditures, Prices, and Consumption (Ottawa: Information Division Agriculture Canada, March, 1979). The same source gives the consumer price index and the subindices for individual selected commodities including coffee, tea, and sugar.

The Data: The United States

The data used in the analysis of the demand for coffee in the United States were obtained from published sources. Data on per capita consumption of coffee, and total consumption of coffee are from Statistical Abstract of the United States, published by the United States Department of Commerce. The same source gives data on total annual population levels in the United States, annual disposable income, and the average annual retail prices of coffee, tea, and sugar. Average annual wholesale prices of cocoa, coffee, and tea are obtained from various issues of International Financial Statistics, (Washington, D.C.: International Monetary Fund).

Some Problems in Using Time Series Data

In analysing time series data, the researcher normally assumes that the errors associated with observations are independent of each other. When this is not the case, that is, when autocorrelation has occurred, the interpretation of results is very difficult. The problem of autocorrelation can be detected by the well known and widely used Durbin-Watson (D.W.) test. This test involves the calculation of the D.W. variable. The acceptable calculated D.W. variable should be close to 2; this would imply that there is no serial correlation.[1] Positive correlation is associated with the D.W. statistic values which are significantly below 2, whereas negative serial correlation is associated with D.W. values significantly above 2. In addition there is a region of indeterminancy where D.W. statistic values lies between d_L and d_u.[2] Two widely used methods to correct for serial correlation are those of Cochrane-Orcutt and Hildreth-Lu. The former was utilized in this study as dictated by the computer package used (T.S.P.).

Multicollinearity is another problem frequently encountered with analysis of time series data. This problem exists when two or more theoretically independent variables

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1 The terms serial correlation and autocorrelation are used interchangeably.

2 For mathematical derivations and explanations, see, Robert S. Pindyck, and Daniel L. Rubinfeld, Econometric Models and Economic Forecasts, New York: MacGraw Hill Book Company, 1976), p. 114.

are significantly correlated. In this case, it becomes difficult to interprete the strength or weakness of the effects of the variables included in the model as independent variables. A frequently used method to detect the problem is to apply a simple test of correlation on the supposedly independent variables. A simple correlation coefficient value which deviates from zero indicates the presence of multicollinearity. When this is the case, one of the variables considered to be of least relevance to the model is dropped. This requires a priori knowledge on the variables used. However, as Harnet and Murphy note,[1] this is not the most efficient way of treating this problem. Dropping the variable could leave the model unrepresentative of the existing relationships. In other words, dropping the variable may introduce a specification bias.

The Models Postulated in the Study

The models were selected for use on the basis of the theory of demand and also on the basis of consistency with similar studies in this field. The theory of demand suggests that for an individual the quantity demanded or consumed depends upon the price of that good and the prices of

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1 D.L. Harnet and J.L. Murphy, Introductory Statistical Analysis, (California : Addison-Wesley Publishing Company, Inc., 1975) p. 463.

other related goods as well as on the individuals' disposable income. An aggregate market demand can be derived from the individual demand curves.[1] Single equation models are postulated and are tested using least squares techniques in this study. As Foote notes, this method of analysis produces coefficients that can be used to derive estimates that are statistically significant.[2] Additional support for the use of the single equations instead of simultaneous equations can be found in the works of the authorities such as Fox[3] and Working.[4] Fox lists four questions which a researcher must provide answers to before he decides which approach is appropriate to his work. These four questions are as follows:

(1) Is supply of the given commodity affected by current price?

(2) Is consumption of a given commodity significantly affected by current price or by the demand for export?

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1 H.A. John Green, Consumer Theory, (London: The MacMillan Press Ltd., 1978), pp. 136-146.

2 Richard J. Foote, Analytical Tools for Studying Demand and Price Structure, Agriculture Handbook No. 146, (Washington, D.C., United States Department of Agriculture, August, 1958), p. 58.

3 K.A. Fox, The Analysis of Demand for Farm Products, United States Department of Agriculture Technical Bulletin No. 1081 (Washington, D.C.: U.S.D.A., May, 1953).

4 E.J. Working, "Progress in the Study of Demand for Farm Products", Journal of Farm Economics, Vol. 37 (December, 1955).

(3) Is consumer income significantly affected by changes in price or by the demand for export storage?

(4) Is the supply or any competitive commodity affected by the current price of the given commodity?"[1]

If each of these four questions could be answered in the negative, statistical demand function fitted by least squares should approximate the "time" or structural demand function. If an analyst has serious reservations on any of these questions, Fox suggests that it may be necessary to fit data using simultaneous equations.

The answers to these questions as applied to coffee appear to be negative.[2] As explained earlier coffee has a long gestation period of about 2 to 4 years from time of planting to the time of the first harvest. Thus current prices do not significantly affect the supply of coffee. The extent of consumption and storage may be affected by the price of coffee but there is no demand for the export of coffee from North America. Besides, consumer incomes are not affected by changes in the prices or the consumption of coffee. Thus on the basis outlined above, the use of single equation models to explain the extent of variation in average annual total

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1 K.A. Fox, Demand for Farm Products, pp. 11-14.

2 The ideas for the following section were obtained from N.E. Sackey, "Analysis of the demand for cocoa in Canada and the United States, 1950-1972", Department of Rural Economy Alberta. Unpublished Thesis, 1976, p. 27.

and per capita consumption of coffee in both the United States and Canada appears to be appropriate here. Moreover, Working's work models suggests that the use of simultaneous equation in explaining the variation in the dependent variable may not significantly add to the quality of the analysis. Working argues that simultaneous equations do not necessarily provide reliable demand elasticities in a majority of cases.[1]

In line with the above theoretical framework, single equation models were formulated. Per capita consumption and total consumption of coffee were considered as alternative dependent variables. Personal disposable incomes and population levels were proposed as important demand shifters. The prices of related commodities such as tea, cocoa, and sugar were also considered to explain the variation in per capita and total consumption of coffee. In some limited cases, time was taken as a proxy for changes in tastes and preferences. All models are fitted separately for Canada and for the United States over the period from 1955 to 1972. The single equation models were tested in both linear and logarithmic forms.

Models Formulated for United States

The following models were tested using the T.S.P. program.[2] The price and income variables, as noted below,

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[1] E.J. Working, "Progress in the Study of Demand for Farm Products", Journal of Farm Economics, Vol. 37 (Dec. 1955) p. 971.

[2] J.P. Chenier (ed.), Time Series Processor, Computing Services Reference Manual 34, University of Alberta, June, 1978.

were fitted in real terms by deflating the nominal series by the appropriate indices. The models were also rerun on the undeflated price and income data.

Model 1

This model postulated that year to year variations in the consumption of coffee (in per capita terms) is explained by the price of coffee and by income expressed in real terms. The model in its linear form is as follows:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \mu \qquad \text{... 1a}$$

where $\frac{Q_c}{N}$ = annual per capita consumption of coffee (in pounds per capita);

P_c = real average annual wholesale prices of coffee at the New York Coffee and Sugar exchange (U.S. dollars per 100 pounds);

$\frac{Y}{N}$ = real annual per capita income (U.S. dollars).

In its logarithmic formulation this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N}$$

$$+ \log \mu \qquad \text{... 1b}$$

where the variables are as defined above.

Model 2

This model postulated that the annual variation in the consumption of coffee (in per capita terms) is explained by the real prices of coffee and cocoa and by per capita income. The model in its linear form is as follows:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_3 P_{cc} + \mu \qquad \ldots\ 2a$$

where $\frac{Q_c}{N}$, P_c, and $\frac{Y}{N}$ are as defined above

and P_{cc} = real average annual wholesale prices of cocoa at New York Cocoa exchange (U.S. dollars per 100 pounds).

The model in its logarithmic formulation is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N}$$

$$+ \beta_3 \log P_{cc} + \log \mu \qquad \ldots\ 2b$$

where the variables are as defined above.

Model 3

This model postulated that per capita consumption of coffee is dependent upon the real average annual wholesale price of coffee, the average annual wholesale price of tea, the average annual wholesale price of cocoa, and on per capita income. In its linear form this model is:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_3 P_{cc} + \beta_4 P_t + \mu \quad \ldots \text{ 3a}$$

where $\frac{Q_c}{N}$, P_c , and $\frac{Y}{N}$ are as defined above

and P_t = real average annual wholesale prices of tea at the New York Tea exchange (U.S. dollars per 100 pounds).

In its logarithmic form this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N} + \beta_3 \log P_{cc}$$

$$+ \beta_4 \log P_t + \log \mu \quad \ldots \text{ 3b}$$

where the variables are as defined above.

Model 4

In model 4, the per capita consumption of coffee was hypothesized as the dependent variable. The independent explanatory variables were postulated to be the average annual wholesale prices of coffee, the average annual wholesale price of sugar and per capita income.

Model 4 states that:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_5 P_s + \mu \quad \ldots \text{ 4a}$$

where $\frac{Q_c}{N}$, P_c , and $\frac{Y}{N}$ are as defined above

and P_s = real average annual wholesale prices of sugar (U.S. dollars per 100 pounds).

In its logarithmic form this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N}$$

$$+ \beta_5 \log P_s + \log \mu \qquad \ldots \text{ 4b}$$

where the variables are as defined above.

Model 5

This model postulated that the annual variation in demand for coffee (in absolute terms) is explained by the real average annual wholesale price of coffee and by real total annual income. The model in its linear formulation is as follows:

$$Q_c = \beta_o + \beta_1 P_c + \beta_6 Y + \mu_o \qquad \ldots \text{ 5a}$$

where Q_c = total annual consumption of coffee (in thousands metric tons);

Y = real total annual income (in U.S. dollars).

In its logarithmic form this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_c + \beta_6 \log Y$$

$$+ \log \mu \qquad \ldots \text{ 5b}$$

where the variables are as defined above.

Model 6

In model 6, the total annual consumption of coffee was hypothesized as the dependent variable. The independent explanatory variables were postulated to be the real average annual wholesale prices of coffee, total real annual income and the population level in the various years. This model in its linear form is:

$$Q_c = \beta_o + \beta_1 P_c + \beta_6 Y + \beta_7 N + \mu \qquad \ldots \; 6a$$

where Q_c, P_c, and Y are as defined above

and N = population level in the United States (millions).

In its logarithmic form this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_c + \beta_6 \log Y$$

$$+ \beta_7 \log N + \log \mu \qquad \ldots \; 6b$$

The variables are as defined above.

Model 7

This model hypothesized that the annual total consumption of coffee depends upon the real average annual wholesale price of coffee, real average annual wholesale price of cocoa, real average annual wholesale price of sugar and real total annual income. The model in its linear form is as follows:

$$Q_c = \beta_o + \beta_1 P_c + \beta_3 P_{cc} + \beta_5 P_s + \beta_6 Y + \mu \quad \ldots \text{ 7a}$$

where the variables are as defined above.

In its logarithmic form this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_c + \beta_3 \log P_{cc} + \beta_5 \log P_s$$

$$+ \beta_6 \log Y + \log \mu \quad \ldots \text{ 7b}$$

where the variables are as defined above.

Model 8

In model 8, the total annual consumption of coffee was hypothesized as the dependent variable. The independent explanatory variables were postulated to be the real average annual wholesale price of coffee, the real average annual wholesale price of tea, the real average annual wholesale price of sugar, real total national income, and population level in various years. Model 8 states:

$$Q_c = \beta_o + \beta_1 P_c + \beta_4 P_t + \beta_5 P_s + \beta_6 Y + \mu \quad \ldots \text{ 8a}$$

where the variables are as defined above.

In its logarithmic form this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_c + \beta_4 \log P_t + \beta_5 \log P_s$$

$$+ \beta_6 \log Y + \log \mu \quad \ldots \text{ 8b}$$

where the variables are as defined above.

Model 9

In this model, per capita annual consumption of coffee was hypothesized as the dependent variable. The independent explanatory variables were postulated to be the real average annual retail prices of coffee and real per capita income.

Model 9 in its linear form states:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_{rc} + \beta_2 \frac{Y}{N} + \mu \qquad \text{... 9a}$$

where $\frac{Q_c}{N}$ and $\frac{Y}{N}$ are as defined previously

and P_{rc} = real average annual retail price of coffee (U.S. dollars per pound).

In its logarithmic formulation this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_{rc} + \beta_2 \log \frac{Y}{N} + \log \mu \qquad \text{... 9b}$$

where the variables are as defined above.

Model 10

In model 10, the annual per capita consumption of coffee was hypothesized as the dependent variable. The independent explanatory variables were postulated to be the real average annual retail prices of coffee, real per capita income, and time.

The model in its linear formulation is as follows:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_{rc} + \beta_2 \frac{Y}{N} + T + \mu \qquad \ldots \text{10a}$$

where $\frac{Q_c}{N}$, P_{rc}, and $\frac{Y}{N}$ are as defined previously

and T = time in years from 1955 = 1 to 1977 = 23.

In its logarithmic form model 10 is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_{rc} + \beta_2 \log \frac{Y}{N}$$

$$+ \log T + \log \mu \qquad \ldots \text{10b}$$

where the variables are as defined above.

Model 11

In model 11, the per capita consumption of coffee was hypothesized as the dependent variable. The independent explanatory variables were postulated to be the real average annual retail prices of coffee, the real average annual retail prices of tea, the real average annual retail prices of sugar, and real annual per capita income.

The model state:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_{rc} + \beta_2 \frac{Y}{N} + \beta_4 P_{rt} + \beta_5 P_{rs} + \mu \ldots \text{11a}$$

where $\frac{Q_c}{N}$, P_{rc}, and $\frac{Y}{N}$ are as defined previously

and P_{rt}= real average annual retail prices of tea (U.S. dollars per pound);

P_{rs}= real average annual retail prices of sugar (U.S. dollars per pound).

In its logarithmic form this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_{rc} + \beta_2 \log \frac{Y}{N}$$

$$+ \beta_4 \log P_{rt} + \beta_5 \log P_{rs} + \log \mu \quad \ldots \text{ 11b}$$

where the variables are as defined above.

Model 12

In model 12, the per capita consumption of coffee was postulated to be the dependent variable. The explanatory variables were real average annual retail prices of coffee, real average annual retail price of sugar, and real annual per capita income.

In its linear formulation this model is:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_{rc} + \beta_2 \frac{Y}{N} + \beta_4 P_{rt} + \mu \qquad \ldots \text{ 12a}$$

where the variables are as defined above.

In its logarithmic formulation this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_{rc} + \beta_2 \log \frac{Y}{N}$$

$$+ \beta_4 \log P_{rt} + \log \mu \qquad \ldots \text{ 12b}$$

where the variables are as defined above.

Model 13

This model, postulated that annual variation in the demand for coffee (in absolute terms) at the retail level is explained by the real average annual retail price of coffee, the real average annual retail price of sugar, and real annual total income. The model in its linear formulation is:

$$Q_c = \beta_o + \beta_1 P_{rc} + \beta_5 P_{rs} + \beta_6 Y + \mu_o \qquad \ldots \text{ 13a}$$

where the variables are as defined above.

In its logarithmic form this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_{rc} + \beta_5 \log P_{rs}$$

$$+ \beta_6 \log Y + \log \mu_o \qquad \ldots \text{ 13b}$$

where the variables are as defined above.

Model 14

In this model, annual total consumption of coffee was postulated to be the dependent variable. The explanatory variables were: real average annual retail price of coffee,

real average annual retail price of sugar, real average annual retail price of tea, and annual total income. The model in its linear form is:

$$Q_c = \beta_o + \beta_1 P_{rc} + \beta_4 P_{rt} + \beta_5 P_{rs} + \beta_6 Y + \mu \quad \ldots 14a$$

where the variables are as defined above.

In its logarithmic form this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_{rc} + \beta_4 \log P_{rt} + \beta_5 \log P_{rs} + \beta_6 \log Y + \log \mu \quad \ldots 14b$$

where the variables are as defined above.

Model 15

In model 15, the dependent variable was considered to be annual total consumption of coffee. The independent variables were: real average annual retail price of coffee, real average annual retail price of tea, real average annual retail price of sugar, real annual total income and population levels. This model in its linear form is:

$$Q_c = \beta_o + \beta_1 P_{rc} + \beta_4 P_{rt} + \beta_5 P_{rs} + \beta_6 Y + \beta_7 N + \mu \quad \ldots 15a$$

where the variables are as defined above.

In its logarithmic form this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_{rc} + \beta_4 \log P_{rt} + \beta_5 \log P_{rs}$$

$$+ \beta_6 \log Y + \beta_7 \log N + \log \mu \qquad \ldots \text{ 15b}$$

where the variables are as defined above.

The above models were also tested using nominal data on prices and income (i.e., undeflated prices and incomes) as models 16 through 30. The results of models 1 through 15 are presented and discussed in the next chapter while the results of models 16 through 30 are presented in the appendix.

<u>Models Formulated for Canada</u>

Model 31

In this model it was postulated that per capita consumption of coffee in Canada is dependent upon the real average annual wholesale price of coffee and the real annual per capita income. In its linear form this model is:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \mu \qquad \ldots \text{ 31a}$$

where $\frac{Q_c}{N}$ = annual per capita consumption of coffee (in pounds per capita);

P_c = real average annual wholesale price of coffee at the New York Coffee and Sugar exchange (U.S. dollars per 100 pounds);

$\frac{Y}{N}$ = real annual per capita income (Canadian dollars).

In its logarithmic formulation this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N} + \log \mu \quad \ldots\ 31b$$

where the variables are as defined above.

Model 32

This model postulated that year to year variation in the consumption of coffee (in per capita terms) is explained by the real average annual wholesale prices of coffee, real average annual wholesale prices of cocoa, and real annual per capita income. The model in its linear form is as follows:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_3 P_{cc} + \mu \quad \ldots\ 32a$$

where $\frac{Q_c}{N}$, P_c, and $\frac{Y}{N}$ are as defined above.

and P_{cc} = real average annual wholesale prices of cocoa at the New York Cocoa exchange.

In its logarithmic formulation this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N}$$

$$+ \beta_3 \log P_{cc} + \log \mu \qquad \ldots \ 32b$$

where the variables are as defined above.

Model 33

This model postulated that annual variation in the consumption of coffee (in per capita terms) is explained by the real average annual wholesale price of coffee, the real average annual wholesale price of tea, the real average annual wholesale price of sugar, and real annual per capita income. The model in its linear form is as follows:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_4 P_t + \beta_5 P_s + \mu \qquad \ldots \ 33a$$

where $\frac{Q_c}{N}$, P_c, and $\frac{Y}{N}$ are as defined previously

and P_t = real average annual wholesale price of tea at the New York Tea exchange;

P_s = real average annual wholesale price of sugar at the New York Coffee and Sugar exchange.

In its logarithmic formulation this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N}$$

$$+ \beta_4 \log P_t + \beta_5 \log P_s + \log \mu \qquad \ldots 33b$$

where the variables are as defined above.

Model 34

This model postulated that year to year variation in the consumption of coffee (in per capita terms) is dependent upon the real average annual wholesale price of coffee, the real average annual wholesale price of tea, and real annual per capita income. The model in its linear form is as follows:

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_5 P_s + \mu \qquad \ldots 34a$$

where the variables are as defined above.

In its logarithmic formulation this model is:

$$\log \frac{Q_c}{N} = \log \beta_o + \beta_1 \log P_c + \beta_2 \log \frac{Y}{N}$$

$$+ \beta_5 \log P_s + \log \mu \qquad \ldots 34b$$

where the variables are as defined above.

Model 35

This model postulated that annual variation in the consumption of coffee (in absolute terms) is dependent upon the real average annual wholesale price of coffee and real annual per capita income. The model in its linear form is as follows:

$$Q_c = \beta_o + \beta_1 P_c + \beta_6 Y + \mu \qquad \ldots \text{ 35a}$$

where P_c is as defined above

and Q_c = real annual total consumption of coffee in Canada (in '000 metric tons);

Y = real total annual income (in millions Canadian dollars).

In its logarithmic formulation this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_c + \beta_6 \log Y + \log \mu \qquad \ldots \text{ 35b}$$

where the variables are as defined above.

Model 36

This model postulated that year to year variation in the consumption of coffee (in total terms) is explained by the real annual average wholesale price of coffee, the real average annual wholesale price of sugar,

and real annual total income. The model in its linear form is as follows:

$$Q_c = \beta_o + \beta_1 P_c + \beta_5 P_s + \beta_6 Y + \mu \qquad \text{...36a}$$

where the variables are as defined previously.

In its logarithmic formulation this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_c + \beta_5 \log P_s + \beta_6 \log Y$$

$$+ \log \mu \qquad \text{...36b}$$

where the variables are as defined previously.

Model 37

Model 37 postulated that annual variation in the consumption of coffee (in total terms) is explained by the real annual wholesale price of coffee, the real average annual wholesale price of cocoa, the real average annual wholesale price of sugar, the real annual total income, and the population level in various years. The model in its linear form is as follows:

$$Q_c = \beta_o + \beta_1 P_c + \beta_3 P_{cc} + \beta_5 P_s + \beta_6 Y$$

$$+ \beta_7 N + \mu \qquad \text{...37a}$$

where Q_c, P_c, P_{cc}, P_s, and Y are as defined previously

and N = population level in Canada (millions).

In its logarithmic formulation this model is:

$$\log Q_c = \log \beta_o + \beta_1 \log P_c + \beta_3 \log P_{cc} + \beta_5 \log P_s$$

$$+ \beta_6 \log Y + \beta_7 \log N + \log \mu \qquad \ldots 37b$$

where the variables are as defined above.

The above models were also run using nominal data on prices and income (i.e., undeflated prices and incomes) as models 38 through 44 respectively. The results and a discussion of these are presented in the next chapter.

CHAPTER IV

RESULTS OF THE REGRESSION ANALYSIS

In this chapter, the results of the econometric analyses of the demand for coffee in North America are presented. The regression results based on the analysis of aggregate annual time series data covering the period from 1955 to 1977 are presented. The economic implications of the results are also discussed.

The criteria used in judging which model formulations showed the best fit and in comparing the significance of the estimated models are listed below. These criteria are:

1) whether or not the estimated coefficients are statistically significant at the conventional levels of significance;[1]
2) whether or not the estimated coefficients carry the expected signs which are postulated by theory;
3) whether or not the coefficients of multiple determination indicate a good fit to the data;

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[1] By conventional levels is meant, 10 per cent, 5 per cent, and 1 per cent levels of significance.

4) whether or not residuals indicate the presence of serial correlation (autocorrelation), as measured by the Durbin-Watson statistic; and,

5) whether or not the problem of multicollinearity exists, as indicated by the simple correlation coefficients between independent variables.

Further, elasticities of demand calculated from the estimated coefficients are also presented in this chapter. The analysis begins with the following presentation of regression results concerning the demand for coffee in the United States.

Estimated Coefficients of the Coffee Demand Function Using Wholesale Prices and Per Capita Income and Consumption

The United States

Models 1, 2, 3, and 4 as outlined in the previous chapter were tested in both linear and logarithmic formulations. The basic objective at this stage of the analysis was to establish whether or not the per capita consumption of coffee is affected by own-price, per capita income level, and by the prices of related commodities such as tea, cocoa, and sugar. It was expected that the price of sugar would not substantially affect coffee consumption since, for dietary reasons, a relatively small amount of sugar is used

in liquid coffee in the United States. However, tea and cocoa were expected to be close substitutes for coffee.

Table 4-1 presents the results of regressing the per capita consumption of coffee on the wholesale prices of coffee, cocoa, tea, and sugar as well as on per capita income in the United States, in accordance with models 1, 2, 3, and 4 of Chapter III. As can be seen from Table 4-1, all the estimates of the coefficients associated with the price of coffee (β_1) carry the expected, negative signs in both linear and non-linear forms. In general, the estimated coefficients are also statistically significant: these are significant at the 1 per cent level in models 1a, 1b, 2b, 4a, and 4b of Table 4-1; significant at the 5 per cent level in model 2a; significant at the 10 per cent level in model 3a; and insignificant at the conventional levels in model 3b. The estimate ($\hat{\beta}_1$) had a range from -0.05 to -0.01 in the linear models, and from -0.33 to -0.07 in the logarithmic models.

Demand theory predicts that for a normal good, income and the quantity demanded should vary directly. Thus, the estimated coefficient on the income variable (Y) should carry a positive sign. Indeed this is the case for models 1, 2, 3b, and 4a of Table 4-1.

TABLE 4-1

RESULTS OF MODELS 1, 2, 3, AND 4, DEMAND FOR COFFEE

IN THE UNITED STATES, 1955-1977

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s + \mu$$

Equation	Model Form	Estimated Coefficients[1] β_o	β_1	β_2	β_3	β_4	β_5	R^2	D.W.
1a	Linear	-2.28 (-0.32)	-0.04*** (-3.45)	0.001* (1.04)	--	--	--	0.9848	1.49+
2a	Linear	-2.30 (-0.33)	-0.03** (-2.28)	0.001* (1.14)	-0.10* (-1.10)	-	--	0.9857	1.51++
3a	Linear	-2.76 (-0.39)	-0.01* (-1.01)	-0.001 (-0.01)	-0.01 (-0.67)	-0.04* (-1.50)	--	0.9877	1.13+
4a	Linear	8.23 (1.05)	-0.05*** (-4.27)	0.001 (0.15)	--	--	-0.11** (-2.21)	0.9873	1.42+
1b	Logarithmic	0.58 (0.04)	-0.28*** (-3.09)	0.23 (0.50)	--	--	--	0.9633	1.89++
2b	Logarithmic	0.43 (0.01)	-0.25*** (-2.55)	0.27 (0.58)	-0.07* (-1.06)	--	--	0.9647	1.99++
3b	Logarithmic	2.00 (0.66)	-0.07 (-0.89)	0.21 (0.59)	-0.04 (-0.95)	-0.44*** (-4.01)	--	0.9815	1.57++
4b	Logarithmic	4.87 (1.03)	-0.33*** (-3.53)	-0.17 (-0.32)	--	--	0.06 (0.08)	0.9659	1.69++

1 t-values are presented in parenthesis.

*** The estimated coefficients are significant at the 0.01 level.

** The estimated coefficients are significant at the 0.05 level.

* The estimated coefficients are significant at the 0.10 level.

++ The hypothesis of no serial correlation is accepted at the 0.05 level.

+ The hypothesis of no serial correlation is accepted at the 0.05 level.

As Table 4-1 shows, the estimated coefficient associated with the cocoa price variable (that is, $\hat{\beta}_3$) is significant at the 10 per cent level in models 2a and 2b, but statistically insignificant in models 3a and 3b. It would appear that cocoa is a complement to coffee, given that the coefficient estimates carry negative signs. The estimated coefficient ($\hat{\beta}_4$) associated with the tea variable is significant at the 1 per cent level in model 3b and at the 10 per cent level in model 3a. Both estimates have negative signs, contrary to what was expected. This would indicate that tea is a complement to coffee. This conclusion appears to be reinforced by the high level of significance of the estimated coefficients on the tea variable, as pointed out.

The estimated coefficient ($\hat{\beta}_5$) on the sugar variable is statistically significant at the 5 per cent level in model 4a, but insignificant at the conventional levels in model 4b.

In general, each of the models showed a high coefficient of determination (R^2). This suggests that the postulated independent variables appear to explain most of the variation in the dependent variable, the per capita consumption of coffee in the United States. In

the linear models, the R^2 varied between 0.9848 and 0.9877, and in the logarithmic formulations it ranged from 0.9633 to 0.9873, as Table 4-1 shows. These R^2's are rather higher than those obtained from testing the models using nominal price and income data. The R^2's obtained from regression results based on nominal variables ranged from 0.9103 to 0.9430 in the linear formulations and from 0.8862 to 0.9181 in the logarithmic formulations.[1]

Autocorrelation was a prevalent problem in all regressions whether data were expressed in real or in nominal terms. In all cases, the autocorrelation was circumvented by using the Cochrane-Orcutt iterative procedure. As a result of using the procedure, the D.W. statistics in Table 4-1 indicate that autocorrelation is no longer a problem or that at least the hypothesis that it exists cannot be supported with certainity. Specifically, in models 1b, 2a, 2b, and 4b the statistics show no presence of autocorrelation, and in models 1a, 3a, 3b, and 4a, the D.W. statistics fall in the inconclusive region. The transformations imposed on the variables by the Cochrane-Orcutt procedure must be borne in mind in interpreting the resulting estimates. The ρ statistics applied in each such transformation are indicated in the later Tables 4-7, 4-8, 4-9, 4-10, 4-11, and 4-12.

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[1] See Table A-1.

Canada

Table 4-2 presents results based on models 31, 32, 33, and 34 outlined in the previous chapter. This table is similar to Table 4-1 except that here Canadian data were used instead of the United States data used in Table 4-1. The exercise at this stage was to establish whether or not the real per capita consumption of coffee in Canada is significantly affected by the real prices of coffee, tea, cocoa, and sugar. As in the case of the United States, sugar prices were not expected to substantially affect the consumption of coffee in Canada. However, tea and cocoa were deemed to be close substitutes of coffee.

Both linear and logarithmic functional forms were used in regressing the per capita consumption of coffee in Canada on coffee, tea, cocoa, and sugar price variables and per capita income.

As can be seen from Table 4-2, all the estimated coefficients ($\hat{\beta}_1$) associated with the coffee price variable carry a negative sign, as expected. In models 32b and 34b, the estimates are statistically significant at the 1 per cent level; in models 31a, 31b, and 34a, they are significant at the 5 per cent level; and in models 32a and 33b the estimates are significant at the 10 per cent level. Thus, other things being equal, as the price of coffee increases, the per capita consumption of coffee in Canada decreases. This finding appears to hold for both the United States (Table 4-1) and Canada (Table 4-2).

TABLE 4-2

RESULTS OF MODELS 31, 32, 33, AND 34 DEMAND FOR COFFEE IN CANADA, 1955-1977

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s$$

Equation	Model Form	Estimated Coefficients[1]						R^2	D.W.
		β_o	β_1	β_2	β_3	β_4	β_5		
31a	Linear	17.02 (30.60)	-0.01** (-1.98)	-0.003*** (-10.64)	--	--	--	0.9491	2.17++
32a	Linear	16.92 (29.16)	-0.009* (-1.08)	-0.003*** (-9.43)	-0.006 (-0.70)	--	--	0.9504	2.11++
33a	Linear	16.43 (10.76)	-0.03** (-1.91)	-0.002*** (-4.34)	--	0.02 (0.85)	-0.06* (-1.68)	0.9563	2.15++
34a	Linear	17.61 (26.41)	-0.02** (-2.40)	-0.002*** (-10.26)	--	--	-0.04* (-1.47)	0.9545	2.15++
31b	Logarithmic	8.66 (18.77)	-0.20** (-4.26)	-0.72*** (-11.16)	--	--	--	0.9556	2.13++
32b	Logarithmic	8.40 (20.87)	-0.17*** (-3.51)	-0.67*** (-11.68)	-0.65* (-1.68)	--	--	0.9611	1.99++
33b	Logarithmic	-0.48 (-0.53)	-0.08* (-1.07)	-0.24** (-2.34)	--	0.03 (0.36)	-0.27 (-0.46)	0.7155	2.32++
34b	Logarithmic	8.85 (23,36)	-0.22*** (-5.62)	-0.69*** (-13.48)	--	--	-0.12** (-2.22)	0.9647	2.08++

1 t-values are presented in parentheses, see notes to Table 4-1.

As Table 4-2 shows, all the estimated coefficients on the per capita income variable carry negative signs. All the estimates are statistically significant at the 5 per cent level. This finding is in contrast to a counter part finding in the case of the United States. In the United States, most of the estimated coefficients on per capita income carried positive signs (see column 5 of Table 4-1). These findings will merit further comment when the price and income elasticities of demand are reported below.

In general, tea and cocoa prices appear not to affect significantly per capita coffee consumption in Canada. In three cases, the estimates associated with the cocoa and tea price variables were found not to be statistically significant at the conventional levels (Table 4-2); and in one case (model 32b), the estimate on the cocoa price variable was significant at the 10 per cent level, but did not carry the expected sign. The estimated coefficient on the tea price variable has the expected sign as Table 4-2 shows. However, the two estimates shown in the table are insignificant at the conventional levels. That the estimates on the tea price variable are positive is in contrast to the counterpart results for the United States.

In regard to sugar, the estimated coefficient on the price variable is significant at the 10 per cent level in two out of the four cases shown in Table 4-2, and at the 5 per cent level in one case, but insignificant at the

conventional levels in one case. However, all the estimates carry negative signs, as expected. Thus, it appears at this stage that coffee consumption in Canada is significantly affected by changes in sugar prices. In addition, coffee and sugar appear to be complements in Canada, as in the United States.

The coefficients of determination (R^2) are reasonably high throughout the models in Table 4-2. This suggests that the postulated independent variables explain much of the variation in per capita coffee consumption in Canada, just as they did in the case of the United States. The initial results (not shown here) had indicated the presence of positive autocorrelation as the relevant D.W. statistics were very low. The Cochrane-Orcutt iterative procedure was used to circumvent the autocorrelation. Thus the D.W. statistics shown in Table 4-2 are relatively high and indicate absence of the autocorrelation problem. The appropriate ρ values are indicated in the later presented tables.

Estimated Coefficients of the Coffee Demand Function using Wholesale Prices and Aggregate Income and Consumption

The United States

As noted earlier, the results in Tables 4-1 and 4-2 are based on models where the dependent variable (coffee consumption) and income are expressed in per capita terms. In this section, regression results of models in which the

two variables were expressed in aggregate, rather than per capita, terms are discussed. The regressions in the case of the United States were based on models 5, 6, 7, and 8 outlined in Chapter III. Specifically, it was hypothesized that the total consumption of coffee depends on the prices of coffee, tea, and sugar and on population and income in the United States. The results of the regression models are presented in Table 4-3.

As Table 4-3 shows, the estimated coefficients on the coffee price variable all carry the expected, negative signs. These estimates are significant at the 10 per cent level. Specifically, the estimate of β_1 is significant at the 1 per cent level in models 5a, 5b, 6a, and 7a; significant at the 5 per cent level in model 6b; significant at the 10 per cent level in model 8b; and statistically insignificant at the conventional levels in models 7b and 8a. The insignifinance of the estimates in the latter models may be explained by the presence of multicollinearity. Nevertheless the results appear to indicate that coffee prices alone play a major role in explaining the variation in real coffee consumption in the United States. These results are generally consistent with those obtained using per capita consumption and income insofar as the role of coffee prices in concerned.

The signs on the estimated coefficients associated with the income variable are also consistent with the estimates when the consumption and income variable were expressed in

TABLE 4-3

RESULTS OF MODELS 5, 6, 7, AND 8, DEMAND FOR COFFEE IN THE UNITED STATES, 1955-1977

$$Q_c = \beta_o + \beta_1 P_c + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s + \beta_6 Y + \beta_7 N + \mu$$

Equation	Model Form	Estimated Coefficients[1]							R^2	D.W.
		β_o	β_1	β_3	β_4	β_5	β_6	β_7		
5a	Linear	-783.21 (-0.40)	-8.82*** (-3.57)	--	--	--	0.001* (1.12)	--	0.9706	1.95++
6a	Linear	22649.1 (5.53)	-7.03*** (-2.97)	--	--	--	0.002** (1.57)	-101.73*** (-4.42)	0.9761	1.81++
7a	Linear	2000.19 (0.89)	-9.97*** (-3.10)	-0.50 (-0.19)	-22.40* (-1.83)	--	-0.002 (-0.10)	--	0.9764	1.43+
8a	Linear	23343.3 (4.47)	-3.43 (-0.87)	--	9.80*** (3.55)	7.73*** (1.57)	0.0001 (0.62)	-12.60* (-1.19)	0.9834	1.42+
5b	Logarithmic	4.10 (0.61)	-0.28*** (-3.07)	--	--	--	0.28 (0.59)	--	0.9436	1.88++
6b	Logarithmic	39.73 (4.04)	-0.25** (-2.57)	--	--	--	0.36 (0.72)	-6.72** (-2.62)	0.9443	1.93++
7b	Logarithmic	5.85 (1.18)	-0.07 (-0.83)	-0.04 (-0.98)	-0.44*** (-4.05)	--	0.23 (0.68)	--	0.9714	1.58+
8b	Logarithmic	8.90 (1.52)	-0.12* (-1.35)	--	-0.43*** (-3.91)	-0.08 (-0.96)	0.04 (0.08)	-5.32** (-1.77)	0.9718	1.64+

1 t-values are presented in the parenthesis; see the notes to Table 4-1.

per capita form. The estimates of β_6 are all positive. The theory of demand postulates a positive relationship between the quantity demanded and income (except for an inferior good). Hence, the positive signs associated with the estimates of β_6 were expected. However, except for model 5a and 6a the estimates of β_6 in Table 4-2 are statistically insignificant at the 10 per cent level. Further, in the case of models 5a and 6a, the estimated coefficient on the income variable is extremely small in magnitude. In general, in reference to income, results in both Tables 4-1 and 4-3 suggest that this variable does not appear to play an important role in the determination of coffee consumption in the United States. Moreover, the effect of the variable is rather indeterminate as to the direction.

Next, the cocoa, sugar, and tea price variables were added to the independent variables in models 7 and 8. As can be seen from Table 4-3, the estimated coefficient ($\hat{\beta}_3$) on the cocoa price variable bears a negative sign in both models - contrary to what was anticipated. These results can be explained by the presence of multicollinearity. The cocoa price variable was highly correlated to the coffee price variable, with a simple correlation coefficient between them of 0.92. Further, the estimated coefficient associated with this variable ($\hat{\beta}_3$) is statistically insignificant at the 10 per cent level throughout the table. Hence, cocoa prices appear not to influence significantly coffee consumption in the United States.

The estimates ($\hat{\beta}_4$) associated with the tea price variable carries a negative sign in models 7a, 7b, and 8b, contrary to what was expected. However, it bears a positive sign in model 8a. This contradiction in signs may suggest that the relationship between coffee consumption and tea price is not linear as models 7b and 8b postulate. All the estimates associated with the tea price variable are significant at the 10 per cent level.

As indicated earlier, the sugar price variable was included in models 8a and 8b. As Table 4-3 shows, the estimate ($\hat{\beta}_5$) associated with the sugar price variable bears a positive sign in the case of model 8a (where this coefficient is highly significant) and a negative sign in model 8b (when the coefficient is not significant at the conventional levels).

With the belief that the population level should significantly affect coffee consumption, a population variable was included in models 6a, 6b, 8a, and 8b. The estimated coefficient ($\hat{\beta}_7$) associated with the variable is significant at the 10 per cent level in all the models. The coefficient estimate carries a negative sign, contrary to what was expected. One expects population to have a positive influence on the demand for a commodity. Although this does not appear to be the case in the present study, the results reported here are consistent with the results

from the studies reviewed in the previous chapter, and is likely due to the simultaneous trend to decreasing per capita and total coffee consumption levels while population has been increase.

The coefficients of determination (R^2's) in Table 4-3 are as high as those in Table 4-1. They range from 0.9706 to 0.9834 for the linear formulations and from 0.9436 to 0.9718 for the logarithmic formulations. This suggests that the independent variables included in the models explain much of the variation in the dependent variable, coffee consumption in the United States. Further, autocorrelation, as indicated by the D.W. statistic, was a problem in all the initial regressions. As before, the Cochrane-Orcutt iterative procedure was used to circumvent the problem and the ρ values used in this process are indicated in later tables.

Canada

The counterpart of Table 4-3 for Canada is Table 4-4. This table presents results of regressing total coffee consumption in Canada on the wholesale prices of coffee, tea, cocoa, and sugar and on income and population.

As can be seen from Table 4-4, the estimate ($\hat{\beta}_1$) associated with the coffee price variable carries the expected negative sign throughout the models in the table. The

TABLE 4-4

RESULTS OF MODELS 35, 36, AND 37, DEMAND FOR COFFEE IN CANADA, 1955-1977

$$Q_c = \beta_o + \beta_1 P_c + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s + \beta_6 Y + \beta_7 N + \mu$$

Equation	Model Form	Estimated Coefficients[1]							R^2	D.W.
		β_o	β_1	β_3	β_4	β_5	β_6	β_7		
35a	Linear	278.12 (12.41)	-0.21* (-1.18)	--	--	--	-0.003*** (-3.08)	--	0.8648	2.58++
36a	Linear	277.36 (7.55)	-0.11 (-0.35)	-0.15 (-0.76)	-0.03 (-0.07)	--	-0.001** (-2.35)	--	0.8699	2.44++
37a	Linear	-57.69 (-0.82)	-0.24* (-1.32)	0.01 (0.08)	--	-0.56 (-0.87)	-0.003*** (-5.40)	21.82*** (4.86)	0.9155	2.01++
35b	Logarithmic	10.93 (7.72)	-0.12* (-1.67)	--	--	--	-0.47*** (-3.42)	--	0.8812	2.54++
36b	Logarithmic	10.41 (6.54)	-0.06 (-0.75)	-0.04 (-1.00)	-0.07 (-0.72)	--	-0.41*** (-2.81)	--	0.8920	2.44++
37b	Logarithmic	8.91 (28.03)	-0.16*** (-3.94)	1.04*** (5.88)	--	-0.02 (-0.43)	-0.07* (-1.48)	2.84*** (5.36)	0.9381	2.05++

[1] t-values are presented in parenthesis, see notes to Table 4-1.

estimate is statistically significant at the 1 per cent level in model 37b; significant at the 10 per cent level in models 35a, 35b, and 37a; and statistically insignificant in models 36a and 36b.

Further, as regards the income variable, Table 4-4 shows that the estimated coefficients associated with it are all statistically significant at the 10 per cent level or more. These estimates are significant at the 1 per cent level in models 35a, 35b, 36b and 37a. In all models, the estimates of this coefficient ($\hat{\beta}_6$) has a negative sign, contrary to expectations. In the case of the United States, the estimates of the coefficient associated with the income variable were positive in seven out of the eight models shown in Table 4-3. However, in the case of Canada (Table 4-4), all the estimated coefficients on income are negative and significant at the conventional levels. This finding will be further discussed in the later section on elasticities of demand.

Other variables included in the models were cocoa, tea, and sugar prices as well as population. As Table 4-4 shows, the estimated coefficient ($\hat{\beta}_3$) on the cocoa price variable is statistically significant at the conventional levels only in model 37b. The significant estimate is positive as expected. So, in contrast to the United States, coffee and cocoa at the wholesale level appear to be substitutes in Canada. The estimated coefficient ($\hat{\beta}_4$) associated

with the tea price variable is insignificant at the conventional levels in the two cases in Table 4-4. It can be noted that the comparable estimates for the United States were significant at the conventional levels, although these were inconsistent or indeterminate in sign. (Table 4-3).

Column 7 of Table 4-4 shows the results of the estimated coefficient ($\hat{\beta}_5$) associated with the sugar price variable. As with the estimates of β_4, the estimates of the coefficient on the sugar price variable are negative and statistically insignificant at the conventional levels.

Finally, Table 4-4 also shows the estimated coefficients ($\hat{\beta}_7$) on the population variable. The estimate is statistically significant at the 1 per cent level in the two cases shown in the table; and it bears a positive sign in accordance with *a priori* predictions. Thus, in Canada, it appears that as the population increases, total coffee consumption also increases, and vice versa.[1]

In general, the coefficient of determination (R^2) is high, and ranges from 0.8812 to 0.9381. The R^2's in Table 4-4 are generally lower than those obtained when price and income data in nominal terms are used.[2] Thus, it appears

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[1] This finding must, however, be interpreted with caution. The consumption data show that per capita coffee consumption in Canada has been declining since 1962. The per capita consumption levels declined from 12.04 pounds in 1962 to 5.84 pounds in 1977 in Canada. The same tendency has applied to the United States to an even greater extent. Per capita coffee consumption in the United States declined from 19.08 pounds in 1955 to only 5.18 pound in 1977.

[2] See Table A-10.

that real, rather than nominal, prices and incomes are more closely related to consumption in Canada.[1] As before, autocorrelation which was present in the initial results (not shown here), was circumvented by use of the Cochrane-Orcutt procedure.

An examination of the results based on variables expressed in per capita terms (Tables 4-1 and 4-2) and those based on variables expressed in aggregate terms (Tables 4-3 and 4-4) reveal that, in general, there is no great difference between the results of the two types of models. For example, in all the tables, the estimated coefficients on the coffee price variable are negative and significant at the conventional levels; and the estimated coefficients on the income (or per capita income) variable which are significant at the conventional levels are all positive in the case of the United States but negative in Canada's case. Thus, the predictive power (especially as regards signs) of the models do not appear to change significantly irrespective of whether variables are expressed in per capita or aggregate form.

Estimated Coefficients of the Coffee Demand Function Based on Retail-Level Prices

In the previous two sections, results based on

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[1] This also appears to be true for the United States (see Table 4-3 and A-2 of Appendix A).

wholesale prices were discussed. Wholesale prices differ from retail prices by such costs as transport, storage, processing, and packaging as well as by the profit margins of middlemen. Generally, if wholesale prices increase (decrease), retail prices will also increase (decrease). So, wholesale prices are expected to be good proxy for retail prices. However, there may be a time lag between wholesale price changes and retail price changes. Moreover, if any price regulations are imposed, they are imposed on retail rather than wholesale prices. For these reasons whenever retail prices are available they should be preferred to the wholesale prices. Even more fundamental is the feature that demand theory, is derived from postulates and assumptions regarding consumer behaviour and thus relates to retail level prices rather than intermediate prices.

Thus, there are strong arguments for the use of retail level prices in studies such as this. Thus, when wholesale prices are employed as in the previous sections, they must be regarded as approximations of retail prices. In this study it can also be argued that exporters are more concerned with wholesale prices rather than retail prices insofar as they affect the (derived) demand for as well as the supply of their commodity (coffee).

Unfortunately, data on retail level coffee prices in Canada were not available. Such data were available for only the United States. Hence this section presents regression

results based on retail prices for the United States only. The results--is based on models 9, 10, 11, and 12 outlined in Chapter III--are presented in Table 4-5. Both consumption and income are in per capita terms. As before, both linear and logarithmic model formulations were employed.

As can be seen from Table 4-5, the estimated coefficient ($\hat{\beta}_1$) on the coffee price variable has the expected, negative sign in all models, and is statistically significant at the 1 per cent level. The estimate is not significantly different in magnitude from what it was found to be when wholesale prices, rather than retail prices of coffee, tea, cocoa, and sugar were used as independent variables. Thus, other things being equal, a percentage change in wholesale prices would appear to result in the same change in coffee consumption as would result from a similar percentage change in retail prices.

Further, as Table 4-5 shows, the estimated coefficient ($\hat{\beta}_2$) associated with the income variable bears a positive sign in all models. The estimates are significant at the 10 per cent level in models 9a, 10a, 10b, and 11a, and insignificant at the conventional levels in the rest of the models, as indicated in Table 4-5.

TABLE 4-5

RESULTS OF MODELS 9, 10, 11, AND 12, DEMAND FOR COFFEE IN THE UNITED STATES, 1955-1977

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_{rc} + \beta_2 \frac{Y}{N} + \beta_4 P_{rt} + \beta_5 P_{rs} + \beta_8 T$$

Equation	Model Form	Estimated Coefficients[1]						R^2	D.W.
		β_o	β_1	β_2	β_4	β_5	β_8		
9a	Linear	-3.25 (-0.48)	-0.02*** (-3.98)	0.001* (1.31)	--	--	--	0.9863	16.95++
10a	Linear	23.14 (8.87)	-0.02*** (-2.10)	0.001* (1.51)	--	--	-0.95*** (-8.44)	0.9914	1.81++
11a	Linear	-1.05 (-0.16)	-0.02*** (-3.54)	0.001* (1.21)	-0.29* (-1.14)	--	--	0.9869	1.38+
12a	Linear	8.62 (1.18)	-0.02*** (-3.97)	0.0002 (0.15)	-0.30* (-1.28)	-0.08* (-1.75)	--	0.9883	1.49+
9b	Logarithmic	0.57 (0.14)	-0.24*** (-3.19)	-0.24 (-0.52)	--	--	--	0.9641	1.55++
10b	Logarithmic	1.39 (0.35)	-0.26*** (-3.56)	0.57* (1.04)	--	--	-0.88*** (-3.48)	0.9631	1.55+
11b	Logarithmic	1.36 (0.34)	-0.22*** (-3.07)	0.20 (0.44)	-0.25* (-1.47)	--	--	0.9665	1.72++
12b	Logarithmic	4.21 (0.92)	-0.24*** (-3.24)	-0.07 (-0.14)	-0.27* (-1.57)	-0.11* (-1.10)	--	0.9683	1.63+

1 t-values are presented in parenthesis, see the notes to Table 4-1.

Other variables included in models 10, 11, and 12 were tea and sugar prices and time. Time (as a trend variable) was included in model 10. The estimated coefficient on this variable is significant at the 1 per cent level and bears the expected negative sign. This reflects the downward trend per capita consumption. This conclusion is consistent with the observed trends and with the results of other researchers in this field, such as Gray and Timms.[1]

The estimated coefficient ($\hat{\beta}_4$) associated with the tea price variable is significant at the 10 per cent level in both models 10 and 11. It, however, bears a negative sign, contrary to what was expected. Nevertheless, this result is consistent with the results obtained when wholesale rather than retail prices were used as independent variables. Besides, this result is also consistent with Timms' review of the history of coffee.[2] Coffee, rather than tea, is the national non-alcoholic beverage. Since coffee drinking tends to be habitual, it may be hard to switch away from coffee even if coffee or tea prices rise, as long as the rises are within a "reasonable" range.

The estimated coefficient ($\hat{\beta}_5$) associated with the sugar price variable carries the expected negative sign, and

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[1] See Frederick D. Gray, "The Down Trend in the U.S. Coffee Consumption", p. 31; and Daniel E. Timms, World Demand Prospects for Coffee in 1980, p. 35.

[2] Ibid., p. 33.

is statistically significant at the 10 per cent level. Thus, at retail level, contrary to the results from using wholesale price level data, sugar appears to be a complement to coffee.

In general, the postulated independent variables explain most of the variation in the dependent variable. The coefficients of determination R^2's are very high, as Table 4-5 shows. In fact, the coefficients of determination are higher in Table 4-5 than they are in Tables 4-1 and 4-3. Here, the R^2 ranges from 0.9631 to 0.9914 whereas in Tables 4-1 and 4-3, they varied between 0.9633 and 0.9877.

As before, the initial results (not presented here), indicated the presence of autocorrelation. The D.W. statistics were very low. Again, the Cochrane-Orcutt iterative technique was used to correct for autocorrelation. This explains why the D.W. statistics reported in Table 4-5 are reasonably high. The ρ values used in the Cochrane-Orcutt procedure are shown in the later tables in which elasticity estimates are presented.

Next, the above models were tested as models 13, 14, and 15 in which total, rather than per capita, consumption of coffee in the United States is the dependent variable. Again, both linear and non-linear functional forms were employed. The regression results are presented in Table 4-6.

As can be seen from Table 4-6, the estimated coefficient ($\hat{\beta}_1$) on the coffee price variable is significant at the 1 per cent level in all models. The estimate also carries the expected negative sign throughout the models. These results are consistent with those obtained and discussed earlier (Tables 4-1 and 4-3).

TABLE 4-6

RESULTS OF MODELS 13, 14, AND 15, DEMAND FOR COFFEE IN THE UNITED STATES, 1955-1977

$$Q_c = \beta_o + \beta_1 P_{rc} + \beta_4 P_{rt} + \beta_5 P_{rs} + \beta_6 Y + \beta_7 N + \mu$$

Equation	Model Form	Estimated Coefficients[1]						R^2	D.W.
		β_o	β_1	β_4	β_5	β_6	β_7		
13a	Linear	6506.21 (13.92)	-6.63*** (-5.00)	--	-33.04*** (-3.32)	-0.003*** (-5.04)	--	0.9708	1.40+
14a	Linear	7544.42 (8.99)	-6.12*** (-4.36)	-78.28* (-1.29)	-35.17*** (-3.52)	-0.004*** (-5.56)	--	0.9723	1.56+
15a	Linear	18247.3 (4.98)	-5.07*** (-4.24)	--	-14.23* (-1.56)	0.001 (0.80)	-75.67*** (-3.45)	0.9823	1.61+
13b	Logarithmic	19.14 (7.28)	-0.34*** (-4.92)	--	-0.17* (-1.60)	-0.68*** (-3.40)	--	0.9371	1.40+
14b	Logarithmic	23.49 (7.74)	-0.30*** (-4.69)	-0.38** (-1.89)	-0.19** (-4.56)	-0.96*** (-3.01)	--	0.9464	1.62+
15b	Logarithmic	33.01 (3.40)	-0.23*** (-2.76)	--	-0.09 (-0.76)	0.16 (0.27)	-4.89* (-1.76)	0.9459	1.47+

1 t-values are presented in parenthesis, see the notes to Table 4-1.

As regards the income variable, the results in Table 4-6 appear to contradict those in Table 4-1, (as well as those in Tables 4-3 and 4-5). The estimated coefficients all bear negative signs and they are also significant at the 10 per cent level. These significant negative coefficients, from models using absolute rather than per capita consumption and income data and incorporating retail level rather than wholesale price data, suggest that coffee is an inferior good. This conclusion is consistent with Abaelu and Manderscheid's finding in this respect.[1]

Sugar and tea price variables as well as population were included in models 13, 14, and 15. The results in Table 4-6 suggest that tea and coffee are not substitutes. The estimated coefficient associated with the tea price variable in both models 14a and 14b is significant at the 10 per cent level, and has a negative sign. That coffee and tea are complements is consistent with the results in Tables 4-1, 4-3, and 4-5.

The estimated coefficients associated with the sugar price variable are all significant at the 10 per cent level except in model 15b and they all bear the expected negative signs. This confirms similar results in Tables 4-1, 4-3, and 4-5 suggesting that coffee and sugar are complements.

Finally, the estimated coefficient of the population variable in Table 4-6 again, as in Table 4-3, has the anomalous negative sign, and is statistically significant at the 1 per

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[1] See Nduka Abaelu and Lester V. Manderscheid, "U.S. Import Demand for Green Coffee by Variety", p. 240.

cent level. This finding was discussed on page 80.

Again, the coefficients of determination are very high. The R^2 in Table 4-6 varies between 0.9708 and 0.9823 in linear formulations and between 0.9371 and 0.9464 in logarithmic formulations. Lastly, as before, the Cochrane-Orcutt procedure was used to circumvent autocorrelation nothing which was present in the initial results (not shown here).

Estimated Demand Elasticities for Coffee Based on Wholesale Level Prices

In this section, calculated demand elasticities for the United States and Canada are presented and discussed. The elasticities are computed from the estimated coefficients in Tables 4-1 through 4-4. Thus, the elasticity estimates are based on wholesale prices in both the United States and Canada.[1] In interpreting these results, the transformation of the variables involved in the Cochrane-Orcutt procedure must be borne in mind. The procedure enables improving the efficiency of the results but the interpretation of these results is made more difficult. To aid in this interpretation the level of ρ is indicated in each table in which the estimated elasticities are presented.

The United States

Table 4-7 presents the calculated demand elasticities for the United States based on Table 4-1, where consumption

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[1] Note that only elasticities of demand for coffee calculated from estimates which are significant at the conventional levels are shown in the tables of the following section.

TABLE 4-7

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES FOR COFFEE FROM MODELS 1, 2, 3, AND 4, FOR THE UNITED STATES, 1955-1977[1]

Equation	Model Form	Own-Price Elasticity of Demand	Income Elasticity	Cross-Price Elasticity w.r.t. Tea Prices	Cross-Price Elasticity w.r.t. Cocoa Prices	Cross-Price Elasticity w.r.t. Sugar Prices	ρ^2
1a	Linear	-0.12	0.22	--	--	--	0.961
2a	Linear	-0.13	0.22	--	--	--	0.964
3a	Linear	-0.13	0.03	-0.04	-0.27	--	0.963
4a	Linear	-0.16	0.02	--	--	-0.10	0.963
1b	Logarithmic	-0.04	0.001	--	--	--	0.963
2b	Logarithmic	-0.03	0.001	--	-0.07	--	0.961
3b	Logarithmic	-0.01	0.001	-0.44	--	--	0.960
4b	Logarithmic	-0.05	0.001	--	--	--	0.960

1 Based on coefficients significant at the 10 per cent level and over.

2 Signifies the Cochrane-Orcutt transformation parameter.

SOURCE: Calculated from Table 4-1.

and income are expressed in per capita terms. Table 4-8 presents results based on Table 4-3, where consumption and income are in total terms.

As Table 4-7 shows, the calculated own-price elasticity of demand for coffee carries a negative sign as expected. The calculated own-price elasticity of demand for coffee ranges from -0.12 to -0.16 in the linear models and from -0.01 to -0.05 in non-linear models (Table 4-7).

Table 4-7 also shows calculated income elasticities of demand for coffee. The computed income elasticity varies from 0.02 to 0.22 in the linear models, and is 0.001 in the logarithmic models. Besides, the estimates of own-price and income price elasticity of demand for coffee, Table 4-7 also presents calculated cross-price elasticities. The calculated cross-price elasticities shown are the cross-price elasticity of demand for coffee with respect to tea prices, cross-price elasticity of demand for coffee with respect to cocoa prices, and cross-price elasticity of demand for coffee with respect to sugar prices. As can be seen from the table, the estimated cross-price elasticity of demand for coffee with respect to tea is negative. Hence as explained earlier, tea appears to be a complement to coffee. The sign on the estimates of cross-price elasticity of demand for coffee with respect to cocoa prices shown in Table 4-7, suggest that cocoa is a complement to coffee, rather than a substitute as had been

TABLE 4-8

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES FROM MODELS

5, 6, 7, AND 8, FOR THE UNITED STATES, 1955-1977[1]

Equation	Model Form	Own-Price Elasticity	Income Elasticity	Cross-Price Elasticity w.r.t. Tea Prices	Cross-Price Elasticity w.r.t. Sugar Prices	ρ^2
5a	Linear	-0.14	0.23	--	--	0.970
6a	Linear	-0.11	0.46	--	--	0.839
7a	Linear	-0.13	--	-0.40	--	0.969
8a	Linear	-0.06	--	0.20	--	0.856
5b	Logarithmic	-0.28	--	--	--	0.967
6b	Logarithmic	-0.25	--	--	--	0.827
7b	Logarithmic	-0.07	--	--	--	0.972
8b	Logarithmic	-0.12	--	-0.43	-0.08	0.967

1 Based on coefficients significant at the 10 per cent level and over.

2 See note to Table 4-7.

SOURCE: Calculated from Table 4-3.

anticipated. In regard to sugar, the calculated cross-price elasticity suggests that sugar is also a complement to coffee in the United States.

Table 4-8 shows the calculated demand elasticities based on models 5, 6, 7, and 8. As can be seen from the table, the calculated own-price elasticities carry negative signs, as expected. The calculated elasticities in Table 4-8 range from -0.06 to -0.14 in linear models and from -0.02 to 0.28 in the non-linear models. The calculated income elasticities are shown in column three of Table 4-8. The positive sign on these estimates suggest that coffee is a normal good, at least at the wholesale level and where per capita rather than total consumption is postulated as the dependent variable.

In regard to tea and sugar prices, the calculated cross-price elasticities appear to show that tea and sugar are complements to coffee. That tea may be a complement to coffee was not anticipated but is consistent with the results reported in Table 4-7.

Canada

Table 4-9 presents demand elasticities calculated from Table 4-2. As before, the elasticity estimates were based on coefficients significant at the conventional levels.

As expected, the own-price elasticity estimates carry negative signs in both linear and non-linear models. The own-price elasticity of demand for coffee ranges from -0.05 to -0.17 in the linear functional forms, and from -0.08 to -0.22 in the logarithmic formulations. Thus, the price elasticity of demand for coffee appears to be less than unity in absolute terms, that is, coffee consumption is inelastic with respect to coffee price changes in Canada as is also the case in the United States.

Table 4-9 also shows the calculated income elasticities of demand. All the elasticities are negative--implying that in Canada, coffee appears to be an inferior good. The income elasticities range from -0.50 to -0.75 in the linear models and from -0.24 to -0.67 in the logarithmic models.

The last two columns of Table 4-9 present estimated cross-price elasticities of demand for coffee with respect to cocoa and sugar prices. The calculated cross-price elasticity of demand for coffee with respect to cocoa prices is negative contrary to what was expected.

Except for the calculated income elasticities, the results in Table 4-9 are similar to those in Table 4-7 as regards to signs. Thus, if a commodity appears to be a complement (substitute) to coffee in the United States, it

is also a complement (substitute) to it in Canada. However, in regard to income, coffee appears to be an inferior good in Canada (Table 4-9). In regard to sugar, the cross-price estimate carries the expected negative sign. Sugar, as observed earlier (Table 4-8), appears to be a complement to coffee.

Table 4-10 presents calculated estimates of the elasticity of demand for coffee based on Table 4-4 where consumption and income were expressed in aggregate terms. As the table shows, estimates of the own-price elasticity of demand for coffee in Canada range from -0.03 to -0.06 from linear models and from -0.06 to -0.12 from non-linear models. The own-price elasticities are negative, as is expected and consistent with results in Table 4-9.

Column four of Table 4-10 carries the estimates of income elasticity of demand for coffee from models 35 through 37. The income elasticity estimates range from -0.26 to -0.78 in linear models and from -0.07 to -0.47 in the non-linear models. The elasticities are also negative, as before. Table 4-10 also shows the cross-price elasticity of demand for coffee with respect to cocoa prices. This estimate appears to suggest that cocoa is a significant substitute to coffee in Canada.

The results in table 4-7 through 4-10 are based on wholesale level prices. A comparison of the results of calculated elasticities of demand for coffee for the United States

TABLE 4-9

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES FOR COFFEE, FROM MODELS 31, 32, 33, AND 34, IN CANADA, 1955-1977[1]

Equation	Model Form	Elasticity of Demand	Income Elasticity	Cross-Price Elasticity w.r.t. Cocoa Prices	Cross-Price Elasticity w.r.t. Sugar Prices	ρ^2
31a	Linear	-0.05	-0.75	--	--	0.318
32a	Linear	-0.05	-0.75	--	--	0.317
33a	Linear	-0.17	-0.50	--	-0.10	0.282
34a	Linear	-0.12	-0.50	--	-0.07	0.307
31b	Logarithmic	-0.20	-0.72	--	--	0.314
32b	Logarithmic	-0.17	-0.67	-0.65	--	0.195
33b	Logarithmic	-0.08	-0.24	--	--	0.210
34b	Logarithmic	-0.22	-0.69	--	-0.12	0.198

1 Based on coefficients significant at the 10 per cent Level.

2 See note to Table 4-7.

SOURCE: Calculated from Table 4-2.

is also a complement (substitute) to it in Canada. However, in regard to income, coffee appears to be an inferior good in Canada (Table 4-9). In regard to sugar, the cross-price estimate carries the expected negative sign. Sugar, as observed earlier (Table 4-8), appears to be a complement to coffee.

Table 4-10 presents calculated elasticity of demand for coffee based on Table 4-4 where consumption and income were expressed in aggregate terms. As the table shows, calculated own-price elasticities of demand for coffee in Canada range from -0.03 to -0.06 from linear models and from -0.06 to -0.12 from non-linear models. The own-price elasticities are negative, as is expected and consistent with results in Table 4-9.

Column four of Table 4-10 carries the calculated income elasticities of demand for coffee from models 35 through 37. The income elasticity estimates range from -0.26 to -0.78 in linear models and from -0.07 to -0.47 in the non-linear models. The elasticities are also negative, as before. Table 4-10 also shows the cross-price elasticity of demand for coffee with respect to cocoa prices. This estimate appears to suggest that cocoa is a significant substitute to coffee in Canada.

The results in Table 4-7 through 4-10 are based on wholesale level prices. A comparison of the results of calculated elasticities of demand for coffee for the United States

TABLE 4-10

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES FOR COFFEE, FROM MODELS 35, 36, AND 37, IN CANADA, 1955-1977[1]

Equation	Model Form	Own-Price Elasticity of Demand	Income Elasticity	Cross-Price Elasticity w.r.t. Cocoa Prices	ρ^2
35a	Linear	-0.06	-0.78	--	0.730
36a	Linear	-0.03	-0.26	--	0.310
37a	Linear	-0.06	-0.78	--	0.221
35b	Logarithmic	-0.12	-0.47	--	0.725
36b	Logarithmic	--	-0.41	--	0.749
37b	Logarithmic	-0.12	-0.07	1.04	0.804

1 Based on coefficients significant at the 10 per cent level.

2 See note to Tables 4-7.

SOURCE: Calculated from Table 4-4.

(Tables 4-7 and 4-8) with those for Canada (Tables 4-9 and 4-10) shows no significant differences except in regard to income elasticity estimates. As noted earlier, coffee appears to be an inferior good in Canada. The following section presents calculated elasticities of demand for coffee based on coefficients estimated from models where the price data are at the retail rather than wholesale level.

Estimated Demand Elasticities for Coffee Based on Retail-Level Prices

In this section, results of the calculated demand elasticities based on significant coefficients from Tables 4-5 and 4-6 are presented. Thus, this section discusses calculated elasticities of demand for coffee in the United States based on retail level prices.

Table 4-11 presents a summary of the estimated demand elasticities for coffee based on models 9 through 12. The dependent variable is per capita consumption. As the table shows, own-price elasticity estimates are negative, as expected. These estimates range from -0.09 to -0.20 in the linear models and from -0.22 to -0.26 in the logarithmic models. This result is essentially consistent with the studies reviewed in Chapter III. For example, Timms reported estimates of own-price elasticity of demand of a range of

TABLE 4-11

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES FROM MODELS 9, 10, 11, AND 12, FOR THE UNITED STATES, 1955-1977[1]

Equation	Model Form	Own-Price Elasticities of Demand	Income Elasticity	Cross-Price Elasticity w.r.t. Tea Prices	Cross-Price Elasticity w.r.t. Sugar Prices	ρ^2
9a	Linear	-0.20	0.02	--	--	0.963
10a	Linear	-0.09	0.44	--	--	0.724
11a	Linear	-0.09	0.02	-0.13	--	0.961
12a	Linear	-0.09	0.04	-0.13	-0.08	0.956
9b	Logarithmic	-0.24	--	--	--	0.963
10b	Logarithmic	-0.26	0.57	--	--	0.670
11b	Logarithmic	-0.22	0.20	-0.25	--	0.967
12b	Logarithmic	-0.24	0.07	-0.27	-0.11	0.957

1 Based on coefficients significant at the 10 per cent level and over.

2 See note to Table 4-8.

SOURCE: Calculated from Table 4-5.

-0.10 to -0.18.[1]

In column four of Table 4-11 income elasticity estimates based on models 9 through 12 are presented. All the income elasticity estimates carry a positive sign. These ranged from 0.02 to 0.44 and from 0.07 to 0.57 in the linear and non-linear models, respectively. These results are inconsistent with a number of studies that are reviewed in the previous chapter. For example, Timms reported income elasticities of demand for coffee which ranged from -0.13 to -0.53 and George and King reported an estimate of -0.047.[2]

Column five of Table 4-11 presents the estimates of the cross-price elasticity of demand for coffee with respect to tea prices. The calculated elasticities are negative in sign, contrary to expectations. These results are, however, consistent with results reported in Table 4-10 and those of Timms.[3] The calculated cross-price elasticity of demand for coffee in Table 4-11 varied from -0.25 to -0.27 in the non-linear models and was -0.13 in the linear models. However, Timms reported estimates of the cross-price elasticity of

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1 Daniel E. Timms, World Demand Prospects for Coffee in 1980, Table 17, p. 37.

Gray also reported an estimated own-price elasticity of demand of -0.14. See Frederick D. Gray, "The Down Trend in U.S. Coffee Consumption", p. 38.

2 Daniel E. Timms, World Demand Prospects for Coffee in 1980, Table 17, p. 37; and P.S. George and G.A. King, Consumer for Food Commodities in the United States, p. 70.

3 Daniel E. Timms, World Demand Prospects for Coffee in 1980, Table 17, p. 37.

demand for coffee with respect to tea prices of -0.01 and -0.07, slightly lower than those reported in Tables 4-10 and 4-11.

It was not expected that sugar would play any major role in the consumption of coffee in the United States. The estimated coefficient on this variable was significant in models 12a and 12b though the resulting cross-price elasticity estimates (Table 4-11) are relatively small in magnitude. The signs on these suggest that sugar is a complement to coffee.

Turning to models 13, 14, and 15, Table 4-12 presents estimated demand elasticities based on these models. These estimates of the own-price elasticity of demand for coffee are consistent with the earlier findings (Tables 4-7 through 4-11). The calculated own-price elasticity of demand in this case varies between -0.11 and -0.15 and between -0.23 and -0.34 in the linear and in the non-linear models, respectively. These results are consistent with Parikh, who estimated an own-price elasticity of demand for coffee of -0.22.[1]

Table 4-12 also shows the estimates of the income elasticity of demand for coffee. From the table, it can be seen that four of the six estimated income elasticities carry negative signs and the other two carry positive signs. Those

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1 See. A. Parikh, "United States, European, and World Demand for Coffee", p. 491.

TABLE 4-12

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES FROM MODELS 13, 14, AND 15, FOR THE UNITED STATES, 1955-1977[1]

Equation	Model Form	Own-Price Elasticities of Demand	Income Elasticity	Cross-Price Elasticity w.r.t. Tea Prices	Cross-Price Elasticity w.r.t. Sugar Prices	ρ[2]
13a	Linear	-0.15	-0.04	-0.13	-0.17	0.627
14a	Linear	-0.14	-0.68	-0.18	-0.18	0.478
15a	Linear	-0.11	0.91	--	-0.07	0.824
13b	Logarithmic	-0.34	-0.68	-0.17	-0.17	0.564
14b	Logarithmic	-0.34	-0.96	-0.38	-0.19	0.406
15b	Logarithmic	-0.23	0.16	--	-0.09	0.812

1 Based on coefficients significant at the 10 per cent level and over.

2 See note to Table 4-8.

SOURCE: Calculated from Table 4-4.

results which bear positive signs are consistent with a priori predictions and the earlier results (Table 4-11). The estimates of income elasticity in Table 4-12 range from -0.04 to 0.91 in the linear formulations and from -0.96 to 0.16 in the non-linear models. These results which carry negative signs are consistent with a number of studies reviewed in the last chapter.[1]

Table 4-12 also presents the results of the estimated cross-price elasticities of demand for coffee with respect to tea and sugar prices. The calculated cross-price elasticity of demand for coffee with respect to tea prices (column five of Table 4-12) carries a negative sign, contrary to what was expected but in agreement with earlier results of this study (Tables 4-7, 4-9, and 4-11) and those of Timms.[2] The estimates of cross-price elasticity of demand for coffee with respect to real prices ranged from -0.13 to -0.18 in the linear models and from -0.17 to -0.38 in the logarithmic models.

The last column of Table 4-12 shows estimates of the cross-price elasticity of demand with respect to sugar. As can be seen from this table, all the estimates of the

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1 See footnote two, p. 34 and also see Nduka Abaelu and Lester V. Manderscheid, "U.S. Import Demand for Green Coffee Variety", p. 240.

2 Daniel E. Timms, World Demand Prospects for Coffee in 1980, Table 17, p. 37.

elasticity of demand bear negative signs as expected. As when wholesale level price data were used, sugar appears to be a complement to coffee when retail level prices for the United States are considered. The estimates of cross-price elasticity with respect to sugar (Table 4-11) range from -0.07 to -0.18 in linear models and from -0.09 to -0.19 in the non-linear models.

An Overview of the Evidence

In summary, in this chapter an analysis of regression results of the models outlined in the previous chapter has been undertaken. In view of the transformations of the variables included in Cochrane-Orcutt procedure, conclusions which relate only to the general order of the above results will be made. The results concerning the demand for coffee in the United States are similar in many ways to those of Canada. For example, in both countries, the evidence suggests that demand for coffee is inelastic with respect to coffee prices. This is the case whether or not retail prices or wholesale prices are used; and whether or not one considers the per capita consumption or the total consumption of the good.

In general, the estimates of income elasticity of demand for coffee in Canada appear to suggest that coffee is an inferior good. In the case of the United States, the results carried contradictory signs. Caution must be applied in interpreting these results. Further investigation of

expenditure patterns of individuals or households to investigate whether there are appreciable differences associated with different income, age, or ethnic origins might give more useful information. Changes in the nature of the product (particularly the use of blends and solubles) may also have affected taste and preferences and would be better explored by a more disaggregated study.

In general, sugar prices were found to be related to the consumption of coffee in both Canada and the United States. Tea appears to be a complement rather than a substitute in both the United States and Canada.

These findings should be of interest both to exporting and importing countries. For example, the fact that coffee appears to exhibit an inelastic own-price elasticity of demand and the feature that income increases are unlikely to lead to major outward shifts in the demand for coffee it should signal to the exporting countries not to expect dramatic increases in coffee consumption in North America, whatever policies are implemented. Other policy implications of these findings will be briefly noted in the following chapter.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The study focused on the demand for coffee in the United States and Canada. World trends in coffee production, exportation, and consumption were outlined. It was pointed out that although world coffee production has tended to increase over time imports of coffee to North America have had a downward trend. Consumption per capita in North America has been declining since the 1950s.

After a brief review of the literature and evidence on coffee consumption in the United States and Canada, single equation models of the demand for coffee in these regions were formulated and discussed. These were linear models and double-logarithmic models. All of the models were formulated in accordance with consumer theory. The parameters of the models were then estimated, using the Time Series Package (TSP), an econometric computer programme. After discussing regression results, coffee demand elasticities were computed from the estimated coefficients and means of the variables. A discussion of the calculated own-price, income, and cross-price elasticities of demand for coffee was then undertaken.

In the case of the United States, data at both the wholesale price level and the retail price level were employed

in the econometric analyses. Further, both deflated (real) and non-delated (nominal) prices were used in the analyses. However, in the Canadian case, only wholesale prices were used; retail price data for the relevant variables were not available.

The results show that coffee, tea, cocoa, and sugar prices as well as income and population numbers are some of the significant determinants of coffee consumption in the United States. Except for tea, these variables also appear to be the main determinants of coffee consumption in Canada. The coefficient of determination (R^2) was quite high in all the regressions run.

Table 5-1 presents a summary of the major findings in this study insofar as demand elasticities for coffee are concerned. As the table shows, the demand for coffee appears to be inelastic with respect to the coffee prices. In fact, all the (own-price, income, and cross-price) elasticities for coffee were found to be less than unity in absolute terms in both Canada and the United States (see Table 5-1). Further, coffee appears to be an inferior good in Canada; all the relevant calculated income elasticities for the country were negative. In the case of the United States, the direction of the effect of income on coffee consumption was indeterminate; some calculated income elasticities were positive while others were negative. Furthermore, as Table 5-1 shows, cocoa, tea, and sugar appear to be complements to coffee in North America,

TABLE 5-1

SUMMARY OF DEMAND ELASTICITIES FOR COFFEE IN NORTH AMERICA

Type	Country	Elasticity Type	Elasticity Ranges: Dependent Variable at Wholesale Level		Dependent Variable at Retail Level	
			Q/N	Q	Q/N	Q
Linear	U.S.	Own-Price	-0.12 - (-0.16)	-0.06 - (-0.14)	-0.09 - (-0.20)	-0.11 - (-0.15)
		Income	0.02 - 0.22	0.02 - 0.46	0.02 - 0.44	-0.04 - 0.91
		Tea	-0.04	-0.20 - (-0.40)	-0.13	-0.13 - (-0.18)
		Sugar	-0.10	--	-0.08	-0.02 - (-0.18)
		Cocoa	-0.27	--	--	--
	Canada	Own-Price	-0.05 - (-0.17)	-0.03 - (-0.06)	--	--
		Income	-0.50 - (-0.75)	-0.26 - (-0.78)	--	--
		Tea	--	--	--	--
		Sugar	-0.67 - (-0.10)	--	--	--
		Cocoa	--	--	--	--
Logarithmic	U.S.	Own-Price	-0.01 - (-0.05)	-0.07 - (-0.28)	-0.22 - (-0.26)	-0.23 - 0.34
		Income	0.001	0.04 - 0.36	0.77 - 0.57	-0.68 - 0.16
		Tea	-0.44	-0.43	-0.25 - (-0.27)	-0.17 - (-0.38)
		Sugar	--	-0.08	-0.11	-0.09 - (-0.19)
		Cocoa	-0.07	--	--	--
	Canada	Own-Price	-0.08 - (-0.22)	-0.12	--	--
		Income	-0.27 - (-0.69)	-0.07 - (-0.47)	--	--
		Tea	--	--	--	--
		Sugar	-0.12	--	--	--
		Cocoa	-0.65	1.04	--	--

SOURCE: Tables 4-9 through 4-12, the relevant ρ statistics from applying the Cochrane-Orcutt procedure are presented in earlier tables.

although one could have expected the first two of these to be substitutes to coffee.

Implications

In Canada, coffee appears to be an inferior good. Thus, it appears that increased incomes would not result in increased coffee consumption in the country. Moreover, an inelastic own-price elasticity of demand implies that any attempt to reduce coffee prices in the region would not bring forth a proportionate increase in revenues for the coffee producers. This has serious implications for the countries which depend on coffee as their major foreign exchange earner. These countries' efforts to substantially increase their foreign exchange earnings are not likely to succeed. This conclusion is reinforced by the additional finding that all the relevant elasticities are less than unity in absolute terms. In fact, per capita consumption of coffee in North American has been declining since the 1950s.

Barring a major change in consumer preferences for coffee, the results of this study suggest that the producing countries' foreign exchange earnings from coffee are only likely to increase as a result of increases in coffee prices. Since individually the producing countries can hardly effect any price increases, with the possible exception of Brazil, these countries are price takers. However, if they act together as a group, they can bring about changes in prices

through supply management. Given the evidence of inelastic demand, it would be in their interests to increase, or at least to stabilize, coffee prices though such activities would be at the expense of the consumers. To meet the interests of both consumers and producers an international agreement seems essential. Indeed, this was one of the reasons which led to the founding of the International Coffee Agreement (I.C.A.) in 1962. One major problem in maintaining this type of agreement is in the allocation and maintenance of regional quotas -- a problem that is, however, beyond the scope of this study.

Conclusions and Recommendations

It was found that the main determinants of coffee consumption in the United States and Canada are coffee, cocoa, tea, and sugar prices as well as income and population. In the United States, coffee consumption varies directly with population and inversely with coffee, tea, cocoa, and sugar prices, and in Canada it appears to vary directly with population and inversely with coffee, sugar, and cocoa prices and with income. All the relevant elasticities were found to be less than unity in absolute terms in both countries.

The results suggest that it will not be easy for the producing countries to increase their foreign exchange earnings from coffee. There is a need for a long range,

comprehensive coffee agreement, based on the agreement of both consumers and producers. It was in this light that the International Coffee Agreement (I.C.A.) was founded. Such efforts should be continued. Further, there is a need for research into alternative uses for coffee. Coffee markets could be expanded to the advantage of the producers if alternative uses or markets could be developed for this product.

That the demand for coffee is inelastic suggests the desirability of diversification into alternative crops where this is feasible given that coffee supplies are highly variable in being affected by the vagaries of weather, other things being equal.

Finally, a major limitation of this study was the lack of cocoa, tea, and sugar retail price data in the Canadian case. Moreover, people may be turning away from coffee to soft drinks, given the downward trend in the per capita real consumption of coffee in the region. Substantiation of this would call for testing demand models where retail prices of soft drinks are included among the independent variables. Consequently, one also needs retail price data for soft drinks in both countries. In general, further research employing such data could provide refined estimates and more understanding of demand relationship for coffee.

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APPENDIX A

PRESENTATION OF THE MODEL RESULTS WHERE PRICES AND INCOME INCLUDED ARE IN NOMINAL TERMS

The following section presents results based on models where the price and income variables are expressed in nominal terms. There are no substantial differences between results based on real (price, income, and consumption) variables (Tables 4-1 through 4-6), and those based on nominal variables (Tables A-1 through A-6). However, some minor differences can be detected. These differences are due to increases in nominal variables brought about by increases in prices. For example, in the Canadian case nominal per capita consumption and income increased over the sample period while their real counterparts decreased. Consequently, in nominal terms, per capita consumption and per capita income in Canada appear to be positively correlated (Table A-2), while in the real terms they were found to be inversely related.[1] According to the data, population levels increased over the sample period, though not significant. Hence, total consumption, for instance, in the United States appears to be directly related, where price and income variables are in nominal terms. As pointed out above, by implication, real total consumption of coffee decreased over the period. Consequently, real total consumption of coffee varies inversely with population level in the United States.

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[1] See Table 4-2.

TABLE A-1

RESULTS OF MODELS 16, 17, 18, AND 19, DEMAND FOR COFFEE

IN THE UNITED STATES, 1955-1977.

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s + \mu$$

Equation	Model Form	Estimated Coefficients[1]						R^2	D.W.
		β_o	β_1	β_2	β_3	β_4	β_5		
16a	Linear	17.91*** (50.14)	-0.01*** (-2.71)	-0.001*** (-5.79)	--	--	--	.9140	1.90++
17a	Linear	17.81*** (55.99)	-0.01** (-1.60)	-0.007*** (-5.80)	-0.001 (-0.12)	--	--	.9103	1.64++
18a	Linear	19.53*** (12.22)	-0.01* (-1.06)	-0.007** (-1.77)	0.001 (0.13)	-0.06*** (-3.60)	--	.9430	1.55++
19a	Linear	17.80*** (60.25)	-0.01*** (-2.70)	-0.008*** (-5.40)	--	--	0.01 (0.52)	.9114	1.82++
16b	Logarithmic	4.47*** (21.40)	-0.13*** (-4.6)	-0.16** (-4.8)	--	--	--	.8862	2.08++
17b	Logarithmic	4.47** (19.12)	-0.13*** (-3.22)	-0.16*** (-4.29)	-0.002 (-0.06)	--	--	.8862	2.08++
18b	Logarithmic	5.77*** (8.12)	-0.03 (-0.50)	-0.23** (-2.35)	0.001 (0.04)	-0.34*** (-4.34)	--	.9181	1.77++
19b	Logarithmic	4.59*** (19.13)	-0.14*** (-4.7)	-0.19*** (-4.4)	--	--	0.04 (0.98)	.8916	2.32++

[1] t - values are presented in parathesis, see notes to Table 4-1.

TABLE A-2

RESULTS OF MODELS 38, 39, 40, AND 41, DEMAND FOR COFFEE

IN CANADA, 1955-1977.

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_c + \beta_2 \frac{Y}{N} + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s + \mu$$

Equation	Model Form	Estimated Coefficients[1] β_o	β_1	β_2	β_3	β_4	β_5	R^2	D.W.
38a	Linear	7.95 (36.40)	-0.01*** (-2.61)	0.006*** (4.55)	--	--	--	.5581	0.88
39a	Linear	7.90 (34.19)	-0.01*** (-1.22)	0.006*** (4.19)	-0.006 (-0.71)	--	--	.5597	0.93
40a	Linear	8.07 (11.11)	-0.01 (-0.81)	0.001* (1.58)	--	0.008 (0.44)	-0.02 (-0.65)	.6874	2.39++
41a	Linear	8.16 (31.66)	-0.02*** (-3.03)	0.001*** (4.12)	--	--	-0.04* (-1.43)	.5923	1.03++
38b	Logarithmic	1.024 (6.09)	-0.13*** (-3.81)	0.21*** (6.74)	--	--	--	.7121	1.25+
39b	Logarithmic	0.97 (5.11)	-0.11*** (-2.46)	0.23*** (6.34)	-0.03 (-0.70)	--	--	.7193	1.24+
40b	Logarithmic	-0.11 (-2.11)	-0.30*** (-9.42)	0.08* (1.60)	--	--	--		
41b	Logarithmic	0.97 (4.97)	-0.13*** (-3.69)	0.23*** (5.18)	--	--	-0.03 (-0.52)	.7161	1.24+

1 t - values are presented in parathesis, see notes to Table 4-1.

TABLE A-3

RESULTS OF MODELS 20, 21, 22, AND 23, DEMAND FOR COFFEE IN THE UNITED STATES, 1955-1977

$$Q_c = \beta_o + \beta_1 P_c + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s + \beta_6 Y + \beta_7 N + \mu$$

Equation	Model Form	Estimated Coefficients[1] β_o	β_1	β_3	β_4	β_5	β_6	β_7	R^2	D.W.
20a	Linear	2948.92 (51.52)	-6.03*** (-5.86)	--	--	--	0.002*** (1.95)	--	.7059	1.14+
21a	Linear	748.89 (0.90)	-3.49*** (-2.65)	--	--	--	-0.05*** (-1.81)	13.40*** (2.66)	.7855	1.73++
22a	Linear	2918.11 (50.01)	-3.88** (-2.33)	3.23* (1.60)	--	--	0.003*** (2.55)	--	.7410	1.11++
23a	Linear	3337.7 (-3.62)	-7.08*** (-4.38)	-1.28 (-0.80)	-1514*** (-.374)	-7.02* (-1.55)	0.004*** (3.94)	--	.8845	1.70++
20b	Logarithmic	7.77 (25.26)	-0.18*** (-6.35)	--	--	--	0.06** (2.28)	--	.7121	1.88++
21b	Logarithmic	4.75 (2.31)	-0.14*** (-2.90)	--	--	--	-0.14 (-0.93)	1.06* (1.44)	.7452	2.09++
22b	Logarithmic	0.43 (0.11)	-0.25* (-.255)	-0.07 (-1.06)	--	--	0.27 (0.58)	--	.9647	1.99++
23b	Logarithmic	2.01 (0.66)	-0.07 (-0.89)	-0.04 (-0.95)	-0.43*** (-4.01)	-0.04 (-0.95)	0.21 (0.59)	--	.9815	1.57+

[1] t - values are presented in parenthesis, see notes to Table 4-1.

TABLE A-4

RESULTS TO MODELS 42, 43, AND 44, DEMAND FOR COFFEE IN CANADA, 1955-1977

$$Q_c = \beta_o + \beta_1 P_c + \beta_3 P_{cc} + \beta_4 P_t + \beta_5 P_s + \beta_6 Y + \beta_7 N + \mu$$

		Estimated Coefficients[1]								
Equation	Model Form	β_o	β_1	β_3	β_4	β_5	β_6	β_7	R^2	D.W.
42a	Linear	182.60 (8.09)	-0.04 (-0.20)	--	--	--	-0.003 (-0.91)	--	.9262	2.66++
43a	Linear	160.82 (9.60)	-0.08 (-0.32)	0.76 (0.49)	0.48 (0.15)	--	0.001*** (2.13)	--	.9323	2.59++
44a	Linear	-101.10 (-2.13)	0.02 (-0.11)	0.008 (0.05)	--	0.03 (0.06)	-0.001 (-0.19)	14.12*** (3.11)	.9552	2.05++
42b	Logarithmic	2.81 (4.90)	-0.05 (-0.89)	--	--	--	0.24*** (3.65)	--	.9419	2.61++
43b	Logarithmic	2.67 (3.88)	-0.03 (-0.43)	-0.02 (-0.53)	-0.01 (-0.12)	--	0.26*** (3.60)	--	.9429	2.47++
44b	Logarithmic	-0.64 (-1.37)	-0.10** (-1.75)	0.05 (1.35)	--	0.004 (0.06)	0.15* (1.21)	2.38*** (4.97)	.9643	2.20++

[1] t - values are presented in the parenthesis, see notes to Table 4-1.

TABLE A-5

RESULTS OF MODELS 24, 25, 26, AND 27, DEMAND FOR COFFEE IN

THE UNITED STATES, 1955-1977

$$\frac{Q_c}{N} = \beta_o + \beta_1 P_{rc} + \beta_2 \frac{Y}{N} + \beta_4 P_{rt} + \beta_5 P_{rs} + \beta_8 t + \mu$$

Equation	Model Form	Estimated Coefficients[1] β_o	β_1	β_2	β_4	β_5	β_8	R^2	D.W.
24a	Linear	17.25 (29.60)	-0.012*** (-3.56)	-0.005*** (-2.61)	--	--	--	.9223	1.82++
25a	Linear	16.19 (22.68)	-0.02*** (-4.46)	0.001* (1.33)	--	--	-0.26** (-2.26)	.9395	1.91++
26a	Linear	8.62 (1.18)	-0.02*** (-3.97)	-0.0002 (-0.14)	-0.30* (-1.28)	-0.08* (-1.75)	--	.9883	1.49+
27a	Linear	-1.05 (-0.16)	-0.02*** (-3.54)	0.001 (1.21)	-0.29 (-1.19)	--	--	.9869	1.38+
24b	Logarithmic	4.30 (14.32)	-0.008*** (-3.08)	-0.16*** (-3.39)	--	--	--	.8505	1.56++
25b	Logarithmic	4.54 (5.29)	-0.07** (-1.54)	-0.20* (-1.45)	--	--	0.01 (0.30)	.8510	1.55+
26b	Logarithmic	4.67 (14.30)	-0.05* (-1.50)	-0.22*** (-4.53)	-0.10* (-1.29)	0.08** (-1.60)	--	.8733	1.73+
27b	Logarithmic	4.47 (12.41)	-0.06** (-1.37)	-0.18*** (-3.49)	-0.07 (-0.79)	--	--	.8555	1.58+

[1] t - values are in the parenthesis, see notes to Table 4-1.

TABLE A-6

RESULTS OF MODELS 28, 29, AND 30, DEMAND FOR COFFEE IN

THE UNITED STATES, 1955-1977

$$Q_c = \beta_o + \beta_1 P_{rc} + \beta_4 P_{rt} + \beta_5 P_{rs} + \beta_6 Y + \beta_7 N + \mu$$

Equation	Model Form	Estimated Coefficients[1] β_o	β_1	β_4	β_5	β_6	$\beta_7 N$	R^2	D.W.
28a	Linear	2880.09 (25.79)	-4.25*** (-6.52)	--	-7.79** (-1.77)	0.001*** (2.52)	--	.8541	1.79++
29a	Linear	2956.03 (14.31)	-4.05*** (-4.90)	-15.84 (-0.44)	-7.28* (-1.55)	0.001** (2.46)	--	.8562	1.76+
30a	Linear	4.54 (2.61)	-0.03*** (-5.35)	1.5** (2.07)	0.09** (2.11)	0.33*** (2.27)	1.56* (2.43)	.8162	2.07++
28b	Logarithmic	4.40 (16.13)	-0.09*** (-4.09)	--	0.06* (1.22)	-0.19*** (-4.09)	--	.8612	1.65++
29b	Logarithmic	4.67 (14.30)	-0.05* (-1.50)	0.10* (1.29)	0.08* (1.60)	0.22*** (4.53)	--	.8733	1.73++
30b	Logarithmic	3.67 (1.54)	-0.04 (-0.84)	-0.09* (-1.09)	0.07* (1.60)	-0.30* (-1.59)	1.60** (1.81)	.7043	1.75++

1 t- values are presented in parenthesis, see notes to Table 4-1.

TABLE A-7

SUMMARY OF THE ESTIMATED COFFEE DEMAND ELASTICITIES FROM MODELS 16, 17, 18, AND 19, FOR THE UNITED STATES, 1955-1977.[1]

Equation	Model Form	Own Price Elasticity of Demand	Income Elasticity	Cross Price Elasticity w.r.t. Tea Prices
16a	Linear	-0.04	-0.24	--
17a	Linear	-0.04	-1.72	--
18a	Linear	-0.04	-0.01	-0.24
19a	Linear	-0.04	-0.12	--
16b	Logarithmic	-0.13	-0.16	--
17b	Logarithmic	-0.13	-0.16	--
18b	Logarithmic	-0.03	-0.23	-0.34
19b	Logarithmic	-0.14	-0.19	--

[1] Based on coefficients significant at the 10 per cent level and over.

SOURCE: Calculated from Table A-1.

TABLE A-8

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES FOR COFFEE, FROM MODELS 38, 39, 40, AND 41 IN CANADA, 1955-1977.[1]

Equation	Model Form	Own Price Elasticity of Demand	Income Elasticity
38a	Linear	-0.06	-1.68
39a	Linear	-0.05	0.17
40a	Linear	-0.06	0.13
41a	Linear	-0.06	0.20
38b	Logarithmic	-0.13	0.21
39b	Logarithmic	-0.11	0.23
40b	Logarithmic	-0.11	0.30
41b	Logarithmic	-0.13	0.23

1 Based on coefficients significant at the 10 per cent level.

SOURCE: Calculated from Table A-2

TABLE A-9

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES OF COFFEE FROM MODELS 20, 21, 22, AND 23 IN THE UNITED STATES, 1955-1977.[1]

Equation	Model Form	Own Price Elasticity of Demand	Income Elasticity	Cross Price Elasticity w.r.t. Tea Prices	Cross Price Elasticity w.r.t. Sugar Prices
20a	Linear	-0.11	0.51	--	--
21a	Linear	-0.06	-1.27	--	--
22a	Linear	-0.07	0.76	--	--
23a	Linear	-0.11	0.18	--	-0.05
20b	Logarithmic	-0.18	0.06	--	--
21b	Logarithmic	-0.14	-0.14	--	--
22b	Logarithmic	-0.25	--	--	--
23b	Logarithmic	--	--	-0.43	--

1 Based on coefficients significant at the 10 per cent level and over.

SOURCE: Calculated from Table A-3.

TABLE A-10

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES OF COFFEE FROM MODELS 24, 25, 26, AND 27, FOR THE UNITED STATES, 1955-1977.[1]

Equation	Model Form	Own Price Elasticity of Demand	Income Elasticity	Cross Price Elasticity w.r.t. Tea Prices	Cross Price Elasticity w.r.t. Sugar Prices
24a	Linear	-0.04	-1.11	--	--
25a	Linear	-0.06	-1.23	--	--
26a	Linear	-0.10	-0.20	--	--
27a	Linear	-0.10	-0.26	-0.03	--
24b	Logarithmic	-0.03	-0.33	-0.15	0.09
25b	Logarithmic	-0.07	-0.20	--	--
26b	Logarithmic	-0.05	-0.22	-0.10	0.08
27b	Logarithmic	-0.06	-0.18	-0.07	--

[1] Based on coefficients at the 10 per cent level and over.

SOURCE: Calculated from Trable A-4.

TABLE A-11

SUMMARY OF THE ESTIMATED DEMAND ELASTICITIES OF COFFEE FROM MODELS 28, 29, AND 30, IN THE UNITED STATES, 1955-1977.[1]

Equation	Model Form	Own Price Elasticity of Demand	Income Elasticity	Cross Price Elasticity w.r.t. Tea Prices	Cross Price Elasticity w.r.t. Sugar Prices
28a	Linear	-0.11	-0.001	--	-0.04
29a	Linear	-0.11	-0.001	-0.04	-0.04
30a	Linear	-0.001	0.42	0.004	0.001
28b	Logarithmic	-0.09	-0.19	--	0.06
29b	Logarithmic	-0.05	-0.22	0.10	0.08
30b	Logarithmic	-0.04	-0.30	-0.09	0.07

1 Based on coefficients significant at the 10 per cent level and over.

SOURCE: Calculated from Table A-5.

APPENDIX B

AVERAGE ANNUAL WHOLESALE AND RETAIL PRICES OF COFFEE, COCOA, AND TEA IN CANADA AND THE UNITED STATES

TABLE B1-1

AVERAGE ANNUAL WHOLESALE PRICES OF COFFEE, COCOA, AND TEA, IN CANADA AND THE UNITED STATES, 1955-1977

Year	Wholesale Prices of Coffee[1] (Col. 1)	Wholesale Prices of Coffee[2] (Col. 2)	Wholesale Prices of Cocoa (Col. 3)	Wholesale Prices of Tea (Col. 4)
	U.S. Dollars Per 100 Pounds			
1955	37.00	57.30	37.40	64.80
1956	20.68	5840	27.10	57.20
1957	35.28	57.40	30.40	58.70
1958	37.57	4841	4390	56.80
1959	28.72	36.97	33.60	56.30
1960	20.18	36.60	28.60	59.40
1961	18.48	36.01	22.70	57.50
1962	20.63	33.96	20.80	55.63
1963	27.86	34.11	25.33	53.10
1964	35.58	47.36	23.43	55.00
1965	31.27	44.78	17.18	54.00
1966	35.28	40.79	24.43	48.20
1967	34.72	37.93	29.07	45.90
1968	33.46	37.48	34.40	46.00
1969	27.43	40.27	45.68	42.60
1970	33.69	53.94	34.17	44.61
1971	35.72	45.17	26.77	45.81
1972	33.54	52.68	32.26	50.70
1973	41.53	56.83	64.40	48.30
1974	55.42	56.83	97.91	62.00
1975	61.05	82.58	75.44	68.80
1976	87.90	149.48	92.79	74.30
1977	127.63	267.15	171.96	139.79

[1] Uganda

[2] Brazil

SOURCE: Columns (1-4): International Monetary Fund, International Financial Statistics (Washington D.C., I.M.F., Annual issues).

TABLE B1-2

AVERAGE ANNUAL RETAIL PRICES OF COFFEE, TEA AND SUGAR

IN THE UNITED STATES, 1955-1977

Year	Retail Price of Coffee (Col. 1)	Retail Prices of Tea (Col. 2)	Retail Prices of Sugar (Col. 3)
	U.S. Cents Per Pound		
1955	52.2	7.15	10.4
1956	51.2	6.75	10.6
1957	49.8	6.64	11.0
1958	43.9	6.57	11.3
1959	35.6	6.57	11.4
1960	34.3	6.52	11.6
1961	32.4	6.47	11.8
1962	30.4	6.40	11.7
1963	30.3	5.47	13.6
1964	39.6	5.36	12.8
1965	37.6	5.13	11.8
1966	36.6	4.5	12.0
1967	34.2	4.17	12.1
1968	34.0	6.07	12.2
1969	33.4	6.10	12.4
1970	44.4	6.31	13.0
1971	95.4	6.45	13.6
1972	92.7	6.49	13.9
1973	104.0	6.61	15.1
1974	122.9	7.20	32.3
1975	133.4	8.75	37.2
1976	187.3	9.03	24.0
1977	342.2	10.79	21.6

SOURCE: Col. (1-3) United States Department of Commerce, Bureau of the Cencus, Statistical Abstract, various issues. (Washington, D.C.: Government Printing Office.)

APPENDIX C

NATIONAL DISPOSABLE INCOME, CONSUMER PRICE INDEX, AND POPULATION LEVELS IN THE UNITED STATES AND CANADA

TABLE C1-1

AVERAGE ANNUAL PER CAPITA CONSUMPTION OF COFFEE IN THE UNITED STATES AND CANADA

Year	Per Capita Consumption of Coffee in U.S. (Col. 1)	Per Capita Consumption of Coffee in Canada (Col. 2)
	(green beans equivalent)	(green beans equivalent)
1955	15.3	6.98
1956	15.5	7.40
1957	15.7	7.57
1958	15.9	7.98
1959	15.9	8.68
1960	15.8	8.36
1961	15.9	8.67
1962	15.9	9.14
1963	16.2	9.05
1964	15.5	8.77
1965	14.8	8.70
1966	14.8	8.11
1967	14.8	9.29
1968	14.8	9.54
1969	14.1	8.99
1970	13.4	9.55
1971	13.3	8.95
1972	13.9	9.11
1973	13.7	9.29
1974	12.9	9.23
1975	12.4	9.50
1976	12.8	9.50
1977	9.4	9.40

SOURCES: (Col. 1) The United States Department of Commerce, Statistical Abstract (Washington, D.C.) various issues.

(Col. 2) Zuhair A. Hassan, Handbook of food and expenditures, prices and consumption, and Danielle Karamchandani, Edited and published by Information Division Agriculture Canada.

TABLE C1-2

NATIONAL DISPOSABLE INCOME AND POPULATION LEVELS IN THE

UNITED STATES AND CANADA, 1955-1977

Year	Population Level in the U.S. (Col. 1)	Population Level in Canada (Col. 2)	National Disposable Income in the U.S. (Col. 3)	National Disposable Income in Canada (Col. 4)
	(in millions)	(in thousands)	(in billions of $)	(in millions of $)
1955	165.9	15698	328.0	18239
1956	168.9	(c)16080	350.8	20153
1957	172.0	16610	366.1	21107
1958	174.9	17080	367.8	22600
1959	177.8	17483	400.0	23948
1960	180.7	17870	414.5	25075
1961	183.7	18238.3	412.0	26011
1962	186.6	(c)18383	457.7	28243
1963	189.2	18931	481.1	30018
1964	191.9	19291	518.	31725
1965	194.3	19644	566.0	34990
1966	196.6	(c)20014.9	620.6	38278
1967	198.7	20378	653.6	41709
1968	200.7	20701	711.1	46820
1969	202.7	21001	766.0	50911
1970	204.9	21297	798.4	54009
1971	207.1	(c)21568.3	858.1	59943
1972	208.8	21801.5	951.9	68100
1973	210.4	22042.8	1064.6	79219
1974	211.9	22364	1136.0	92499
1975	213.6	22697.1	1217.0	107945
1976	215.1	(c)22992	1364.1	126419
1977	216.8	(R)23257	1520.5	139475

SOURCE: (Col. 1 & 3) The United States Department of Commerce, Bureau of the Cencus, Statistical Abstract, various issues (Washington, D.C.)

(Col. 2 & 4) D.B.S., Statistics Canada, National Accounts Income and Expenditure, cat. no. 13-201, Annual issues.

TABLE C1-3

CONSUMER PRICE INDEX IN THE

UNITED STATES AND CANADA

Year	Coffee (Col. 1)	Canada Sugar (Col. 2)	All Items (Col. 3)	The United States all Items (Col. 4)
		1971 = 100		1967 = 100
1955	110.4	75.7	67.5	80.2
1956	115.4	76.3	68.5	81.4
1957	104.8	101.0	70.7	84.3
1958	89.8	86.8	72.6	86.6
1959	76.5	77.0	73.4	87.3
1960	74.7	77.2	74.3	88.7
1961	75.6	78.8	75.0	89.6
1962	77.3	78.6	75.9	90.6
1963	76.3	129.2	77.2	91.7
1964	91.9	116.2	78.6	92.9
1965	94.4	81.1	80.5	94.9
1966	95.0	78.5	83.5	97.2
1967	91.6	76.9	86.5	100.0
1968	89.6	77.7	90.0	104.2
1969	87.4	89.0	94.1	109.8
1970	100.2	92.4	97.2	116.3
1971	100.0	100.0	100.0	121.3
1972	98.0	125.9	104.8	125.3
1973	106.9	130.7	112.7	133.1
1974	122.4	339.2	125.0	147.7
1975	134.4	320.6	138.0	161.2
1976	191.5	211.0	148.9	170.5
1977	385.3	185.6	160.8	181.5

SOURCES: (Col. 1-3), Zuhair A. Hassan, Danielle Karamchandani, Handbook of food and expenditures, prices and consumption, Edited and published by Information Division, Agriculture Canada.

(Col. 4) The United States Department of Commerce, Statistical Abstract (Washington D.C., 1978)